ENGINEERING LIBRARY

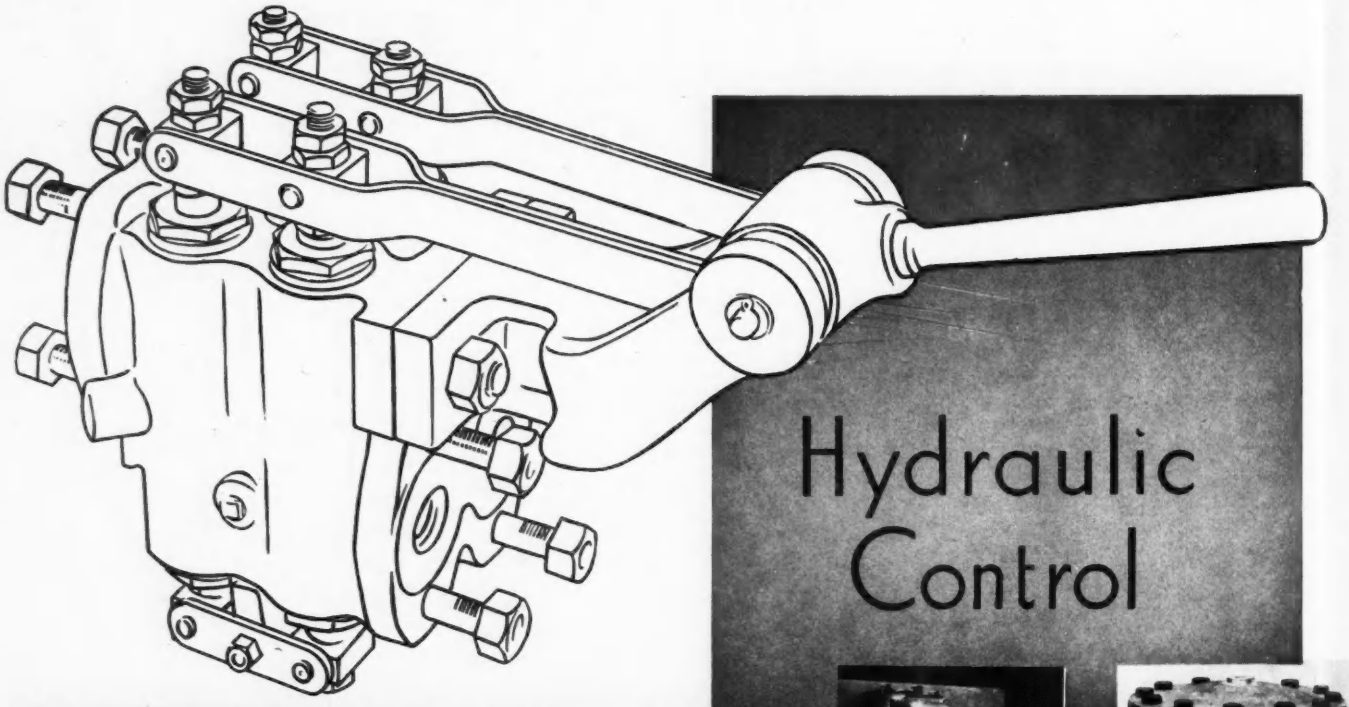
AUG 7 1950

The Engineer

VOL. CXC—No. 4930 28, ESSEX ST., STRAND, LONDON, W.C.2 JULY 21, 1950

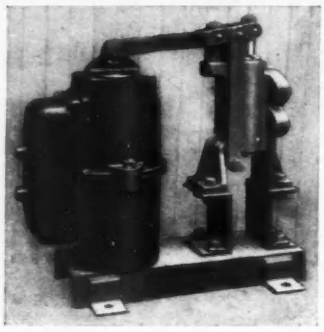
Established 1856 Price 1s. 6d. By Inland Post 1s. 9d. Registered as a Newspaper

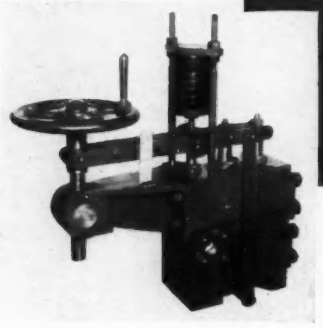
LARSSEN
Box Pile Dolphins at MASHUR, Persian Gulf.
In the construction of 22 mooring and berthing dolphins for oil tankers, more than 2,000 tons of Larssen box piles section B.P.4 were used, in lengths up to 96 feet.
These piles were accurately driven with B.S.P. pile-driving equipment under difficult conditions, where ease of handling without risk of damage was an important factor.
They have the high bearing capacity and bending strength so essential in dolphins and other marine structures.
Consulting Engineers to the Anglo-Iranian Oil Co. Ltd.
Messrs. Rendel, Palmer & Tritton.
Contractors — Messrs. Kinnear, Moodie & Co.
BSP
THE BRITISH STEEL PILING CO. LTD., Kings House, 10 Haymarket, London, S.W.1
Telephone: TRAfalgar 1024/8
Telegrams: Pilingdom, Lesquare, London

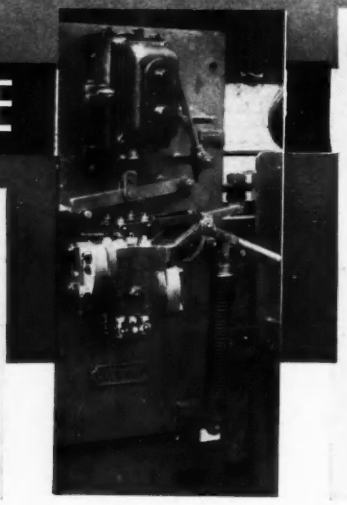


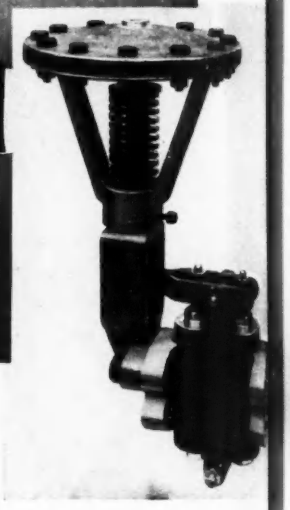
Hydraulic Control

THE HOMEYARD VALVE









The illustrations show various methods of control applied to Homeyard valves for particular functions: first a single-ported valve with solenoid operation which can be arranged for automatic action or for local or centralised control. Secondly, a handwheel operated combined Homeyard valve unit suitable for two different inlet pressures, and thirdly a solenoid-operated Homeyard valve for working pressure of 1,000 lb. per sq. in. The fourth picture shows a Homeyard valve for diaphragm operation by compressed air.

This poppet-type valve is of highly developed design and fulfils as nearly as possible the role of an ideal hydraulic control valve.

Homeyard valves are suitable for water or oil media and are available in sizes from ¼" to 3" diameter. Construction is robust and compact and among the features which have led to their wide-spread adoption are finger-light ease of operation, drip-tightness or even ooze-tightness when properly maintained, generous flow passages imposing minimum obstruction to flow, and general simplicity. Regrinding and repacking are greatly facilitated by the excellent accessibility.

Homeyard valves are standardized in two types, one single ported for the control of single-acting cylinders and similar mechanisms, the other double ported (illustrated above in outline) for the control of double-acting cylinders, of pairs of single-acting cylinders working together, and of similar plant.

Special valves are also available for a wide range of uses and some of these are illustrated above.

A useful brochure "Modern Hydraulic Control Valves," which describes fully these and many other types is available on request.

HEAD OFFICE AND WORKS - KILMARNOCK, SCOTLAND

Branch Offices at

LONDON, MANCHESTER, BIRMINGHAM, BOMBAY AND CALCUTTA

Glenfield

GLENFIELD & KENNEDY, LIMITED, KILMARNOCK

A Seven-Day Journal

The First National Airway

FROM the beginning of next month all aircraft approaching London Airport on the main trunk air routes from the Atlantic will complete the last 250 miles of their flight within the first National Airway to come into operation in the United Kingdom. This airway, known as "Green One," will extend from the Irish Sea to the Metropolitan Control Zone, and will be the first of a network of airways which will eventually cover the British Isles. The system of airways will be designed to increase safety and eliminate risk of collision between aircraft. The airways will, in effect, be sky tunnels 10 miles wide, within which aircraft flying at heights between 5000ft and 11,000ft will be separated from each other at determined heights at intervals of 1000ft. Once within an airway, the aircraft will be under the control of the ground organisation. Each airway will be divided into sections by radio markers placed at regular intervals along its length and the movement of aircraft in an airway will be regulated so that no two aircraft are in the same section at the same height at the same time. Should a section not be clear, no aircraft will be allowed to enter it, but will be "held" over the radio marker until the section has been cleared. It is planned to bring the complete system of National Airways into operation in three phases, of which the completion of Green Airway One (Irish Sea, Strumble Head, Bristol, London) is the first. The second phase will consist of the extension of Green One from London eastwards to Brussels via Maidstone and North Foreland, and the bringing into operation of Airways Amber One (Daventry, Dunsfold, Dieppe, Paris), Amber Two (Daventry, Maidstone, Abbeville, Paris), and Red One (Dunsfold, Maidstone, Amsterdam), with another section leading to the Channel Islands. The third phase will complete the system with the extension of Amber One northwards to Prestwick and Glasgow via Manchester and Liverpool, and the opening of Airways Green Two (Dublin, Liverpool/Manchester, Ottringham, North-West Europe), Red Three (Liverpool/Manchester, Isle of Man, Belfast), and Blue Two (Belfast, Prestwick/Glasgow).

Central Line Jubilee

THE Central London Railway, now the Central Line of London Transport, was opened for traffic fifty years ago on July 30, 1900, and was the world's third electric tube railway. It ran between Shepherd's Bush and the Bank, a distance of 5¾ miles, and provided a new railway link between the residential suburbs of West London and the business quarters of the City. The service was inaugurated with six-car trains hauled by double-ended locomotives having gearless motors with their armatures mounted directly on the axles. This type of drive set up considerable vibration and the geared motors introduced later gave but little better results. In 1904 the locomotives were replaced by motor coaches with B.T.H. multiple-unit control, and each train was built up of seven cars, including the two motor coaches, one at each end. This adoption of multiple-unit operation by the Central London Railway, and at about the same time by the Metropolitan District Railway, marked its introduction into Great Britain. On May 14, 1908, when the Franco-British Exhibition was opened, the Central London Railway brought into service a loop line from Shepherd's Bush to Wood Lane in order to serve the exhibition and improve the terminal working by eliminating the cross-over. Four years later a short length of tunnel was opened at the opposite end of the line from the Bank to Liverpool Street. The railway passed into the control of the Underground Group on January 1, 1913, and the line was extended from Wood Lane to Ealing Broadway on August 3, 1920, to bring its length up to 11 miles. After the formation of the London Passenger Transport Board important schemes were planned for extending the Central Line both eastwards and westwards. These schemes were left in abeyance as a result of the war, but with the end of hostilities the extensions have been carried out stage by stage. Stratford was reached in December, 1946, Leytonstone in May, Greenford in June, Woodford and Newbury Park in December, 1947. The south side of the loop line to Hainault was completed in the following May and the north side in November, 1948. At the same time the line was brought into service as far as Loughton and its extension westwards to West Ruislip completed. The latest, and nearly the final, stage was the opening of the section from Loughton to Epping in September, 1949.

Caisson Sinking at Uskmouth Power Station

THE work of sinking what is believed to be the largest pneumatic caisson in the world is due to commence this week at the site of the Uskmouth generating station, near Newport, Monmouthshire. The first part of the station will have a capacity of 360MW, and to supply the circulating water for the condensers of the six 60MW turbo-alternators a pumping station will be constructed capable of supplying 15,000,000 gallons of water per hour. The River Usk has a rise and fall of approximately 44ft, and as it is essential that the pumps should be able to circulate water at all states of the tide the pumping station will have to be sunk below the bed of the river. The caisson steelwork, which is of welded construction throughout, will weigh 580 tons. The shoe of the caisson has a peripheral cutting edge and there are also two internal cutting edges which divide the steel structure into three bays. These three chambers are connected by emergency access passages. The steel shoe of the caisson has had to be assembled on made-up ground back from the river bank, and will be rolled into position on a bed of brick and stone rubble 6ft deep. This specially prepared bed is intended to prevent any tendency for the caisson to tilt towards the river during the early stages of sinking. The caisson will then be sunk by excavating inside the working chambers, the sinking proceeding at the same rate as the building up of the concrete walls of the pumping station structure. The excavated material will be taken out of each of the three working chambers by means of a fast 2-ton electric derrick, working through air shafts provided in the chambers, and the level of the top of the concrete walls will be kept about 30ft above the mean tide level to prevent any possible flooding by an exceptionally high tide. On reaching a firm bed the sinking weight of the caisson will be in the region of 40,000 tons.

Chairmanship of Babcock and Wilcox, Ltd.

BABCOCK AND WILCOX, Ltd., has announced this week that, at his own request, Lieut.-Colonel Sir John Greenly, K.C.M.G., has retired from the chairmanship of the company, though he is retaining his seat on the board of directors. Sir John, who is sixty-five, was educated at Charterhouse and Trinity College, Oxford, and was trained as a civil engineer. He joined Babcock and Wilcox, Ltd., as a director in 1929, and became deputy chairman in 1932, and succeeded to the chairmanship in 1937. For many years past he has occupied a distinguished place in the engineering industries, and has served on numerous Government and other scientific advisory committees and panels. He has also taken a leading part in the work of many professional institutions, including the Institute of Metals, the Institute of Fuel, and the Institution of Engineering Inspection, of all of which he is a Past-President. In addition, Sir John is a member of the Institution of Mechanical Engineers, the Immediate Past-Chairman of the British Non-Ferrous Metals Research Association, and a Past-President of the Combustion Appliance Makers' Association. Sir John is succeeded as chairman of Babcock and Wilcox, Ltd., by Mr. W. Lionel Fraser, C.M.G., who has recently resigned the joint deputy chairmanship of Tube Investments, Ltd. Mr. Fraser's main association is with Helbert, Wagg and Co., Ltd., of which he is deputy chairman. He is also chairman of Thomas Tilling, Ltd., and deputy chairman of the Atlas Assurance Company.

The School of Gas Turbine Technology

THE School of Gas Turbine Technology maintained by Power Jets (Research and Development), Ltd., has been moved from Lutterworth to Farnborough, Hampshire, where it will be re-opened in October. This school, the only one of its kind, was founded in 1944 to instruct Dominions' Air Force personnel in aircraft jet engines, and now gives instruction in the technicalities of the use of gas turbines in high-speed aircraft, locomotives, road vehicles, ships, industrial applications, &c. It has a wide range of gas turbine equipment and engines, including test houses and a jet aircraft on which installation and practical ground instruction is given. Students on every course at the school undertake actual test bed runs on shaft-power and jet engines. The short, but intensive, theoretical and practical courses on all aspects of gas turbine technology given at the school are of one, two and three weeks' duration. The syllabuses include lectures on basic thermodynamics and theory of design, specialist lectures on the various applications of the gas turbine and its construction, test runs, and on certain aero-engine courses the actual stripping and installation of engines in aircraft. In addition to an industrial gas turbines course lasting three weeks and an aero-engine course lasting two weeks, for British students only, there is a practical and installation course of two weeks' duration. A post-graduate three weeks' course provided for the benefit of students from overseas is, in effect, a combination of the industrial and aero-engine courses.

British Standards Institution

THE annual general meeting of the British Standards Institution was held in London on July 11th, under the chairmanship of the retiring President, Sir William Larke. Mr. Roger Duncalfe, chairman of the General Council, in presenting the annual report, explained that the work had expanded during the year in all sections, both nationally and internationally. The B.S.I. had distributed nearly 750,000 copies of British Standards, many of them volumes of considerable size, and had participated in a number of exhibitions. He also pointed out that the library now holds copies of about 43,000 oversea standards. Reference was made to the growth in Certification Marking and to the work of the B.S.I. in connection with securing approval to electrical appliances for export to Canada. In addition, during the year a further Oversea Committee had been set up in Rhodesia. Sir William Larke, in his closing address, called attention to the valuable work which the B.S.I. had done over so many years. He emphasised the need for the B.S.I. to remain an independent body, supported by all sections of industry and Government under the direct control of an elected Council. Sir William dwelt on the value of standardisation to the community as a whole, and expressed the view that industry must recognise its responsibilities for maintaining this central organisation. At the conclusion of the address a cordial vote of thanks was accorded to Sir William Larke for the many years of service which he had given in the inner councils of the Institution. Sir John Anderson, P.C., F.R.S., was elected President for the ensuing year.

Dynamic Balancing and Its Application to Production Problems

By Lt.-Col. T. CHILD, T.D., B.Sc., M.I.Mech.E.*, and A. BINNS, M.I.Mech.E.†

IF the development of mechanical engineering during the past hundred years or so is examined it will be found that one of the chief causes of increased efficiency is the increase in speed of nearly all moving machinery.

The slow-running steam beam engine can be compared with the later high-speed reciprocating engines, which, in turn, become slow compared with steam turbines. The same process has followed in regard to internal combustion engines and electrical machinery.

Increased power/weight ratio is clearly a criterion of progress in mechanical engineering. Progress in this direction has been made possible with increasing knowledge of metallurgy and the production of new alloys and improved means of precision machining.

Such machining can only be carried out when precision measurements can be made and it is with this method of measurement in particular that this article is concerned.

Basically stated, the problem which the dynamic balancing machine has to solve is the determination of angular position and amount of correction to be applied in, say, two given reference planes of a rotor.

In order to do this the first thing is to reproduce the centrifugal forces caused by the unbalance so that they can be measured. Having measured the centrifugal forces, it is possible then to measure the effect of the corrections carried out.

The earliest types of balancing machine consisted of flexible supporting means for supporting the journals of the rotor and means for rotating it. Lawaczeck, in Germany, appears to have invented the simple resonance type machine as we know it, and in conjunction with Heymann, many machines of this type were made bearing the name Lawaczeck-Heymann. In this design advantage was taken of the resonance principle in order to magnify the effects of small forces produced by still smaller amounts of unbalance. The machine was so arranged that the rotor could be speeded up above the resonance or natural frequency of the spring supporting system of the machine and allowed to coast down and pass through the resonance zone. During this period the small unbalanced forces would excite a vibration, which would build up to a maximum at the exact resonance frequency and then die away again. By this means a movement could be induced which was sufficiently large to be easily discernible and capable of being recorded by means of a stylus on a smoked glass plate or a pencil on a paper chart. Later machines, and particularly the smaller ones, had the refinement of an optical indicator on which a narrow strip of light was caused to oscillate over a scale and so produce an apparently wider band of light, the width of which was a measure of the amount of unbalance.

Some of these machines were also equipped with a stylus carried by a parallel link motion and arranged to draw a diagram on the rotating shaft as the amplitude of vibration increased during resonance. Due to the angularity of the links, the stylus progressed laterally along the shaft so that a series of lines was produced, each one starting at an angular position in accordance with the well-known curve showing the relation of the amplitude of a resonant system to the exciting force. By rotating the rotor first in one direction and then the other, two curves are produced, the intersection giving the position diametrically opposite the unbalance.

Very many machines of this general type were made: there were many variations, particularly in the arrangement of supporting springs and method of drive, but the basic principle remained the same. All these machines, however, were of the non-automatic type, i.e., although they gave information as to the amount and position of unbalance the interpretation of their results was a matter of some skill.

The next important development in balancing machines was the introduction of the compensating or, more correctly termed, counterbalancing gear. In one type of machine a rotating disc carrying an unbalance weight of known amount was provided in the machine, with means for varying its angular relationship and magnitude in respect of the unknown unbalance in the test rotor. By this means it is possible to adjust the compensator so that all vibrations disappear; in other words, the forces induced by the compensator exactly equal the forces produced by the unknown unbalance, both in respect of amount and position. As the position and amount of the compensator are known it is a simple matter to determine the position and amount of correction required on the test rotor.

Some machines of this type have a cradle for supporting the test rotor and a single compensator which is used to measure the forces in either plane, by the simple means of changing the fulcrum point of the cradle. Others have dual compensators, one situated in each pedestal, and one of the latter type has a double-acting compensator with a fulcrum bar situated on the indicating head so that readings can be taken in both planes without stopping the rotor.

It is obvious that this type of machine has very many advantages over the non-automatic type of machine; it transforms what was previously a skilled and delicate operation into a machine tool operator's job.

Although this type of machine has many advantages it has some disadvantages inasmuch as it is more complicated than the non-automatic machine and, as it has extra mechanism, its accuracy and sensitivity is not of such a high order. The rotating mechanism must all be made to a much higher degree of balance than the rotor, which is under test, if the results are to be of any use at all.

Attempts have been made at simplification of the mechanism and one design uses an eccentric coupled through a variable lever device to excite vibrations in opposition to the unbalance vibrations.

Another type of machine uses electromagnets to apply opposing forces to the oscillating cradle. The force is controlled by a resistance and the phase by a commutator device, external current being supplied by a motor generator set.

It is important that these types of machines run exactly at resonance speed, otherwise the angular position will be inaccurate owing to the fact that the unbalance force is being counterbalanced by a vibrating force, not caused by unbalance, and not, therefore, subject to a variation of phase angle due to resonance. In the case of the machines previously described, where the counterbalance force is produced by a rotating unbalance, the phase angle will vary for both exciting force and counterbalance force when the machine is running off resonance and will, therefore, cancel out. The angular position will be accurate but the sensitivity will be reduced accordingly.

This very brief review sketches the general position with regard to mechanical balancing machines, and although there are a number of machines which have not been specifically described these machines are to the same general principle.

New fields of electrical control and instrumentation have been opened up in the last quarter century, of which designers of balancing machines have not been slow to avail themselves.

A perusal of the patent records will reveal the many ingenious attempts which have been made to solve the problem by such means. In one of the earliest designs to be produced commercially, the rotor to be balanced is carried on bearings, which are free to vibrate horizontally, being suspended on wire supports and the bearing carriers are connected to moving coil pick-ups, which are generally similar in form to the ordinary permanent-magnet loudspeaker. Vibration of the pick-ups due to unbalance in the rotor produces an alternating current, which is amplified and applied to a voltmeter, which gives an indication of the amount of unbalance present. To determine the angular position of the unbalance a neon stroboscopic lamp is provided. This lamp is fired by the change in polarity of the a.c. produced by the pick-ups and is arranged to illuminate the rotor so that the latter appears to be stationary. A pointer is provided to indicate the angular position of the unbalance and to identify this position it is usual to provide a numbered tape, which is wrapped round the rotor or to rubber stamp a series of numbers or letters thereon.

Larger type machines dispense with the stroboscopic lamp and provide a control device, by means of which the angular position is shown on a graduated disc. On the smaller machines the rotor is driven by means of a textile belt round the periphery; in the larger machines the drive is by means of a cardan shaft.

Other types of electronic machines have been made using cathode ray oscilloscopes for the indication of unbalance. In some of these machines the signal for angular position is initiated by a photocell which picks up the light reflected from a surface on the rotor, which is suitably marked with a bright spot or a black line in contrast to the remainder, in others a rotating permanent magnet passes a fixed coil and generates a pulse which triggers the C.R.T. trace.

A recently introduced electrical machine dispenses with electronic amplification and the a.c. voltage produced by the pick-ups is passed directly to the moving coil of a sensitive wattmeter type instrument.

The fixed or current coil of the wattmeter is supplied with a.c. provided by a two-phase alternator driven by the rotor spindle of the machine. As the wattmeter indicates the product of the currents flowing in the fixed and moving coils and as the current

* Formerly Manager, Testing Machine Division, W. and T. Avery, Ltd.
† Assistant Manager, Testing Machine Division, W. and T. Avery, Ltd.

in the fixed coils is of constant voltage, the meter will indicate the value of the voltage in the pick-up coil at two reference angular positions; in other words, Cartesian co-ordinates can be employed.

Thus by providing two phases 90 deg. apart two component values can be given, which fully define the amount and angular position of the unbalance vector.

For identification the vector positions are marked *V* for vertical and *H* for horizontal, and the wattmeter has a centre zero so that readings can be plus or minus, according to which quadrant contains the unbalance.

The machine is provided with a four-position control switch, which will give two readings in the left-hand plane and two readings in the right-hand plane.

The diagram, Fig. 1, will show by example how the vector readings will define the position and amount of unbalance. Correction

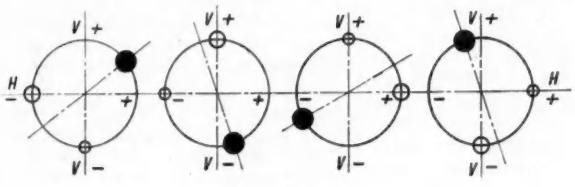


FIG. 1

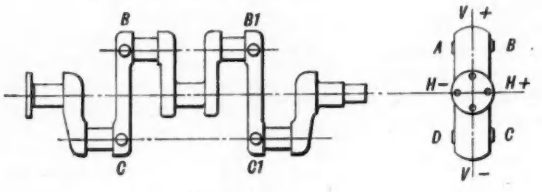


FIG. 2

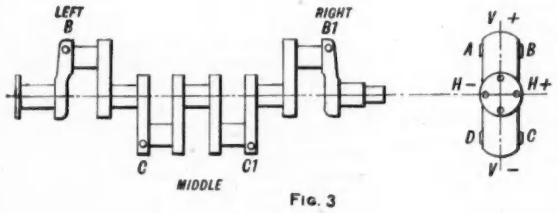


FIG. 3

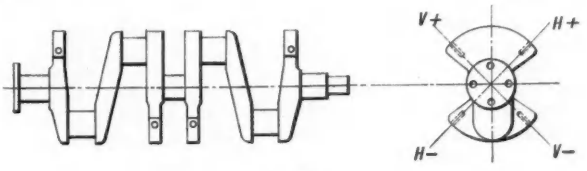


FIG. 4

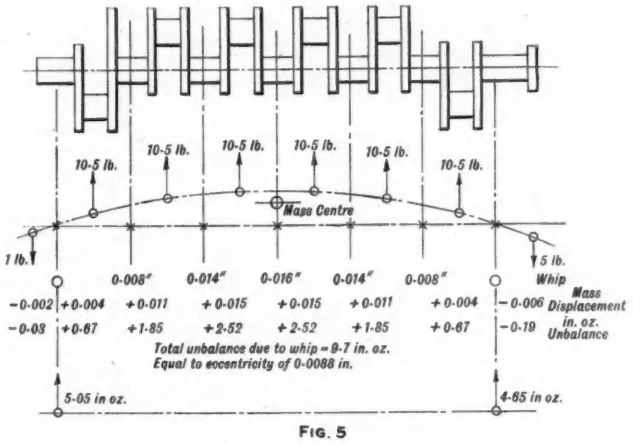


FIG. 5

can be carried out by adding or removing material at the vector points and this method frequently has advantages inasmuch as the positions for correction can be determined. For example, in the case of crankshafts, bosses can be provided at these points, which can be drilled or ground accordingly; in the case of fans, the correction positions can be made to coincide with the blades. However, there are many cases where it is not desirable to make two corrections in each plane owing to the production time involved or due to the shape or design or electrical characteristics of the rotor.

To cater for this requirement an angular control wheel is provided by means of which both phases of the phasing generator can be shifted together in relation to the test rotor. It can be seen from Fig. 1 that if the horizontal phase is shifted so that it coincides with the angle of unbalance, the vertical component will become zero and the horizontal component will become a maximum.

Polarity change switches are provided on the control panel so that the machine can be set to give the correct angular position whether material is to be added or removed for correction purposes.

It should be explained that on electrical machines not using a counterbalancing device the indicated reading is related to the displacement of the mass, and the value of the reading in ounce/inch or gramme/centimetre units will depend on the mass of the rotor. In practice ounce/inch units nearly always have to be translated into other terms, e.g., length of balancing wire or depth and size of hole to be drilled, &c., so that it is just as easy to convert direct from the indicator units into these terms. By calibration it is possible to make each division on the indicator equal to, say, $^1/_{64}$in depth of drill or whatever unit is convenient.

Having sketched the history leading up to the development of the latest types of dynamic balancing machines, it is pertinent to discuss at this stage the question of accuracy and sensitivity. It should be borne in mind that an unbalanced rotor, while constrained to rotate around its geometrical axis, tries to rotate around its mass axis, and in a balancing machine having freedom in, say, a horizontal plane, movement takes place equivalent to the displacement of the mass axis. It is this movement which is measured by the pick-ups and owing to their sensitivity minutely small amounts of movement can be measured.

There is no difficulty in obtaining almost any degree of sensitivity required whether by using amplifiers or otherwise, but there is a practical limit, governed by the tolerances to which the bearings and journals can be made, the corrections introduced and how efficiently the driving torque can be transmitted without the introduction of lateral disturbances.

We can now examine the practical application of dynamic balancing in production work.

The importance of dynamic balance is realised by designers but to the production engineer it is frequently another operation which can become tedious if not tackled in the right way.

The provision of an automatic machine which gives accurate, reliable and rapid information with regard to the location and amount of correction required is the first essential. This information can now be supplied by modern machines in a matter of seconds, but it is of little use saving seconds in the machine if minutes are wasted in correction.

The types of rotors requiring dynamic balancing are legion and consequently the method of correction requires individual attention. Some indications of methods used are given to assist in the solution of these problems.

Electric motor armatures are probably the commonest form of rotors which have to be balanced. D.C. armatures in the smaller sizes usually have their windings bound by tinned copper wire at each end and balancing correction is carried out by the application of solder to these bands. The method has the advantage that the attachment of the correcting weight is simple and rigid and does not affect the electrical characteristics. The disadvantages are the messiness of the soldering with its attendant flux, &c., and the difficulty of putting on a precise amount of solder. In spite of the difficulties, this method is very successfully used and by arranging standard size cored solder the lengths required to suit the amount of unbalance can be determined and calibrated.

Another method of correcting armatures which is frequently used is to insert strips of brass or copper in the winding slots. As the slots run longitudinally it is sometimes difficult to locate the centre of the mass of the correcting piece in the correct plane so that it does not affect the other plane. As the number of slots is limited it is sometimes necessary to divide the correction between adjacent slots in order to locate the correct angular position.

In the case of squirrel-cage rotors correction is often carried out by drilling into the ends of the rotor, but care must be taken with regard to the distribution of metal, as otherwise the electrical characteristics can be upset. Where a fan is fitted this usually provides a convenient place on which corrrection can be made either by removing or by adding material.

Larger electrical rotors frequently have

provision in the way of a concentric slot, in which adjustable weights can be moved and fixed. This method has much to recommend it, although the setting of the weights requires skilled treatment as a direct calibration cannot be made as in the case of the addition or removal of the material.

It will be appreciated that in some cases it would be an advantage to predetermine positions where corrections can conveniently be made and one of the machines, previously described, has provision for unbalance determination by Cartesian co-ordinates in addition to the normal polar method. In other words, correction can be made by adding or removing material at points situated 90 deg. apart.

The case of crankshaft balancing is the same as for any cylindrical body but owing to the shape of the body the treatment requires some further consideration.

The simple theory of dynamic balancing deals only with rigid bodies but many crankshafts are not rigid when supported on two roller bearings and consequently require special treatment.

Taking first of all the treatment of rigid crankshafts, there are two main difficulties in applying corrections :—

(1) Material is usually removed by grinding or drilling and owing to the shape of the crankshaft it is not possible to remove material anywhere on the periphery.

The Cartesian system of determining the position of unbalance is advantageous for this purpose, inasmuch as the points at which correction is to be made are known and fixed. The provision of a driver having a fixed angular relationship to the crank will ensure that the four possible points of correction coincide with certain parts of the crankshaft; if the manufacturers can be persuaded to provide bosses at these points suitable for drilling or grinding the operation is still further simplified. Figs. 2 and 3 show typical crankshafts with correction bosses, e.g., corrections for *V*-plus readings are made on bosses *A* and *B* and for *H*-plus on bosses *B* and *C*. Fig. 4 shows a crankshaft with balancing webs arranged for drilling.

In the case of six-cylinder engine crankshafts the webs are situated at 120 deg. spacing. To convert the 90 deg. vector readings to equivalent values at 120 deg. a polar chart is used.

(2) Owing to the disposition of the webs, it is sometimes difficult to choose two planes for correction purposes. This usually means that it is necessary to have four correction planes instead of two and the choice of planes will depend on which side of the crankshaft it is necessary to make the correction.

As there is no way of knowing which side it will be while the crankshaft is rotating,

EXAMPLE 1

		Left	Middle	Right		Left	Middle	Right
Actual Readings		+35		+13		−10		−23
Treatment	V	—		—	H	+23	−23−23	+23
Result ...		+35		+13		+13	−23−23	—

EXAMPLE 2

		Left	Middle	Right		Left	Middle	Right
Actual Readings		+10		−5		−15		−15
Treatment	V	+ 5	−5−5	+5	H	+15	−15−15	+15
Result ...		15	−5−5	—		—	−15−15	—

it is not possible to make any simple adjustment to the machine to cater for this condition. It is possible, however, to deal with it satisfactorily as the problem becomes a simple case of moments. To avoid calculations a simple rule enables correction values to be ascertained by an addition sum set down in a table. The rule is to add two plus values equivalent to the largest minus value to the left and right positions and two minus values to the middle positions. The examples tabulated above should make this clear.

Fig. 3 shows a diagram of a typical crankshaft treated in this manner. Fig. 4 shows a crankshaft having balanced webs arranged for drilling.

NON-RIGID CRANKSHAFTS

Crankshafts normally run in three or more bearings in the crankcase and are therefore more or less rigidly held. In a balancing machine, however, it is usual, and in fact desirable, to run only on two bearings, so that in the case of a long crankshaft some deflection is bound to occur. Some balancing machines have been designed which have a cradle on which a multiplicity of bearings can be arranged in an attempt to obtain rigid support. This method, however, is undesirable, as to be effective the cradle must be heavy and much stronger than the crankshaft and consequently the additional mass detracts from the performance of the machine. In the ideal balancing machine the only moving mass is the mass of the rotor itself.

The method recommended for dealing with non-rigid crankshafts is to support the crankshaft first of all on the end journals and then measure the deflection at each of the intermediate journals, when running at the balancing speed.

From this data a curve should be drawn which will be generally as Fig. 5. By dividing the crankshaft into sections and multiplying the mass of each section by the deflection of the centre of the mass we obtain the unbalance of each section. The sum of these unbalances gives the total unbalance and dividing this total by the total mass gives the mass displacement.

Draw a line through the mass centre parallel to the support axis; where this line crosses the curve are the nodes of vibration and if these nodes coincide with journals the crankshaft should be supported at these points.

The mass forces on one side will then equal the mass forces on the other side and the deflection due to these forces will have no effect on the balancing result. Frequently, of course, the nodal points do not coincide with convenient journals although in most cases intermediate journals are sufficiently near to reduce the deflection trouble to a negligible amount. If it is desired to reduce the error to zero, then the nodal points can be adjusted to coincide with the journals by the addition of counter masses in the form of ring weights on the ends of the crankshaft. Deflection troubles are sometimes encountered due to the balancing weights put on the crankshaft to compensate for the revolving mass of the connecting rods. As the connecting rods are not present during balancing the balance weights produce a force tending to distort the crankshaft. The solution is to fix split ring weights equal to the calculated revolving mass of the con-rods to the big end journals.

It will be seen that the balancing of non-rigid crankshafts requires careful treatment initially in order to find a solution, but once the solution is found the balancing operation becomes simple and straightforward.

The dynamic balancing of gas turbine rotors has presented many problems, particularly in regard to the compressor portion of the engine, owing to the very small clearances, the high speed and the need for a high degree of accuracy in balance. Correction is made in some cases by the removal of metal from selected parts of the rotor, in other cases by the adjustment of weights in a concentric slot. The addition of material is avoided as far as possible owing to the danger of detachment in service.

In the case of built-up axial flow compressors it is important that the individual discs are in balance within a fairly close tolerance, otherwise distortion may take place in use owing to the mass forces present.

When determining dynamic balancing tolerances in the case of demountable units, due regard should be paid to the fit tolerances of the locating spigots, flanges, &c., as it is often found that the allowable displacement is many times greater than the displacement of the mass axis permitted by the balancing allowance.

Consideration so far has been given to methods of correction and some typical methods described. Of equal importance both from the production point of view and the requirement for accuracy is the question of driving the rotor in the balancing machine. Broadly speaking, two methods are used, in one the rotor is driven by means of a belt or friction disc round its periphery; in the other the drive is applied to the end of the shaft by some sort of universal coupling. The writers favour the latter method, as it more nearly approaches the way in which the rotor is used in practice. No form of driver as yet designed is ideal. The requirement is a means of transmitting the driving torque without any lateral forces and without any friction or restraint; at the same time it should be adaptable to any shape of shaft and be quickly attachable and detachable. While the ideal driving means may not yet have been produced, the amount of development work which has been put into this component is such that the latest types of universal cardan shaft drivers are within measurable distance of being ideal. Electrical dynamic balancing machines have the advantage that the oscillating movement, being small, friction and damping are not so important as on resonance machines, but on the other hand, owing to the higher sensitivity, lateral disturbances due to misalignment, &c., show up to a greater extent.

Canadian Natural Resources Survey

A SURVEY of the natural resources of Canada is to be undertaken by the newly-formed Federal Department of Mines and Technical Surveys. The department plans to give particular attention to surveys of prairie areas which are considered favourable for the production of oil. Discoveries of radio-active minerals will also be examined for their commercial possibilities and a comprehensive investigation of the iron ore regions will be made. To continue the systematic geological mapping of Canada and to make studies of potential resources of gas, oil and minerals, the department has estimated it will spend 1,500,000 dollars; eighty-five field parties will be provided for this work, which will cover all the provinces and the northern areas of the Yukon and the Northwest Territories. The department's topographic survey will receive 1,300,000 dollars, to provide base maps for mining, agriculture, forestry and the engineering industries. About eighty parties will work in the field this year to provide the maps. Two ships have been fitted out to chart Canada's waterways and coasts, thus bringing to thirteen the number of vessels the department proposes to operate. It is estimated that the cost of the entire survey will be about 5½ million dollars.

North of Scotland Hydro-Electric Schemes*

No. II—THE LOCH SLOY PROJECT—PART I

THE Board's first scheme, designated Constructional Scheme No. 1, was published in the middle of 1944. It comprised three separate projects with a combined estimated output of 136MW, situated at Loch Sloy, Loch Morar and Lochalsh. The two small schemes at Loch Morar and Lochalsh, which were completed by the end of 1948, were briefly described in our article last week. By far the largest of the three schemes, however is the Loch Sloy project, with an authorised capacity of 130MW, which is a peak load development centred in the hills between Loch Lomond, Loch Long and Loch Fyne, less than 40 miles from Glasgow. As shown in the accompanying diagram of the project (Fig. 1) Loch Sloy is about 4 miles north of Arrochar, and lies in the hills between Ben Vane (3004ft) and Ben Vorlich (3092ft).

The site has been considered for hydro-electric development several times before the present scheme was postulated. The first proposal of this nature was made in 1906; in 1937 a comprehensive scheme was evolved, which included augmentation of storage by pumping, combined with peak load generation of power. However, for various reasons these schemes were abandoned and it was not until after the formation of the North of Scotland Hydro-Electric Board that a scheme was finally approved.

It is estimated that the present scheme will produce a total of about 120 million kWh of electrical energy annually during a year of average rainfall (115–120in). The main idea behind the scheme is to supply this power to the grid feeding Central Scotland during hours of peak load in the winter months. Thus little power will be generated during the summer, the natural supply of water being much less then than during the winter half-year. However, the auxiliary generating set will operate continuously to supply power for local needs.

A gravity buttress dam with a total length of 1160ft and a maximum height of 160ft is being constructed in mass concrete at the south-eastern end of Loch Sloy and is now approaching completion, thus providing a storage reservoir of 1200 million cubic feet equivalent to 20 million kWh of electrical energy. The natural length of Loch Sloy will be approximately doubled by this development, the length of the reservoir being about 2 miles when filled to the top water level of 934 A.O.D.

Water from this reservoir is led through a tunnel about 1¾ miles long driven through Ben Vorlich, and thence through pipe-lines 1500ft long from the tunnel exit to the generating station beside Loch Lomond at Inveruglas, some 650ft below. Power will be generated in this station from four main vertical shaft turbine generator sets, and an auxiliary 450kW horizontal Pelton wheel set. Each of the main Francis turbines is rated at 45,000 h.p. and each generator will produce 32,500kW at 11,000V, three-phase, and 428 r.p.m. The gross head of water will be 910ft and the mean operating head 840ft, and water will be discharged from the tail-race directly into Loch Lomond. The capacity of the tunnel and pipe-lines is 2200 cusecs, which is equivalent to nearly a quarter of a million tons of water per hour.

Other tunnels and aqueducts, which are shown in Fig. 1, are being constructed to tap, at a high level, streams in neighbouring catchments and hence artificially to increase the catchment supplying the Loch Sloy reservoir. The natural catchment area of the loch is about 6½ square miles, and it was originally intended to increase this figure to 28·5 square miles. During 1948, however, the Loch Sloy extension scheme was published (Constructional Scheme No. 22), which further increased the catchment of the reservoir to 32·5 square miles by additional construction of aqueducts and tunnels, thus increasing the annual yield of power from the original scheme by about 15 million kWh to the figure given above.

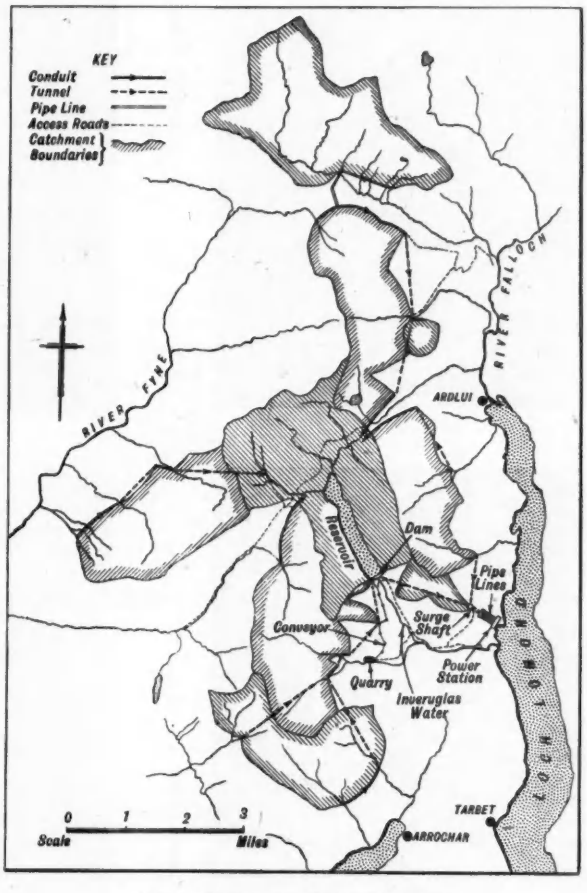


FIG. 1—THE LOCH SLOY PROJECT

In carrying out the scheme James Williamson and Partners, Kennedy and Donkin, and H. P. Tarbolton have been associated with regard to civil and mechanical engineering and architecture respectively. The constructional programme has entailed subdividing the scheme into a number of separate contracts, and the contractors responsible for carrying out the various sections are listed in the table at the end of these articles.

Work was started at Loch Sloy in June, 1945, and it is estimated that the main works will be completed very soon. The construction was planned so that the first generator could produce power before all the works were finished. Thus the dam was completed up to an intermediate level and used for partial storage pending completion of the upper portion. The first generator commenced operation on March 6th last, and completion of the group of turbo-alternators is expected shortly. About 50 per cent of the aqueducts are now completed and delivering water, and the last of the extension aqueducts will be built in about two years time.

PRELIMINARY WORKS

As is usual with a large scheme of this type, situated in undeveloped country, considerable preliminary work was necessary in the construction of access to the site, camp accommodation for the workers, the preparation of quarrying facilities, the supply of power, and the various other preliminary needs of the constructional programme.

A total of about 15 miles of roads have been constructed to provide access to the various sites of the scheme. A new railway station and goods yard were constructed at Inveruglas, and new railway platforms were built at Faslane (Gareloch) and at Glenfalloch, on the West Highland Branch of the former L.N.E.R. The new stations were constructed of precast concrete slab walls filled in between with ashes, and on completion of the project the wall and coping units can be dismantled and re-used elsewhere if the stations are no longer required.

At Inveruglas a steel girder bridge with concrete deck and abutments and with a clear span of 68ft has been built to allow the pipe-lines of the scheme to pass under the West Highland railway embankment. Above this bridge on the western side a concrete safety wall is provided to protect it and the railway from debris caused by blasting during the construction of the works.

A second bridge has been built across the tail-race of the power station to carry the Loch Lomond trunk road. The alignment of this road has been improved as a result of the new lay-out, and approach roads about 400 yards in length were constructed to give access to the new bridge, which is a reinforced concrete structure with two spans. The parapet walls are of rubble masonry from the stone obtained at Coiregrogain quarry. A facing of the same stone has been used on the side of the bridge facing Loch Lomond, but on the power station side the face has been finished in concrete to match the lower parts of the power station structure. Two small twin-span bridges have also been built, one across the spillway channel of the dam and the second across Inveruglas Water, carrying the access road to the quarry.

*No. I, "An Introductory Survey," appeared July 14th.

PROGRESS OF THE LOCH SLOY DAM

FIG. 3—APRIL 1950

FIG. 5—MAY 1949

FIG. 2—MARCH 1950

FIG. 4—JANUARY 1950

Other preparatory works included the building of four new workmen's camps, two at Inveruglas, one at Ardvorloch and one at Butterbridge, and the conversion of an existing military camp at Gareloch; camp accommodation for 1700 men was thus provided. A diesel-electric generating station with four sets of 450kW each and three sets of 600kW each and various temporary transmission lines was established at Inveruglas to supply power for the camps and for operating contractors' plant. Other major items of preliminary works, such as the opening of a new quarry and the construction of cableways and mixing plant, are dealt with in subsequent sections.

In the early stages, before camp accommodation became available, the construction of the preliminary works involved transport of men over long distances. During 1946 about 1400 men, of whom some 600 were prisoners of war, were engaged on this work. As camp accommodation gradually became ready the various main contracts were let and the main works were in full swing by 1947. During 1948 the total number of men employed increased to about 1700 and over 2000 were at work in the autumn of 1949.

The Dam

As previously mentioned, the Loch Sloy dam is a gravity buttress structure with a total length of 1160ft and a maximum height of 160ft, the average height along its length being about 100ft. An arcaded top section will carry a continuous gravity wall supporting a roadway across the top of the dam. There is a spillway at the deepest section and a reinforced concrete valve tower at the centre of the dam on the upstream side. This tower will project 36ft above the top of the dam when completed, provision for the control of the intake of water to the main tunnel (which is described in a subsequent section) being made at the bottom of the tower. The total concrete volume of the dam will be about 200,000 cubic yards.

The dam is situated between two shoulders of rock at a fall in the Inveruglas Water and is founded upon a mica-schist rock. Overlying the mica schist there is sand and gravel of moraine and alluvial origin with peat in places above it. The schistose rock contains many faults and local irrgularities and in some places the footings of the dam were excavated down to a depth of about 60ft. A cut-off trench was excavated at the upstream side of the dam below the general foundation and grout tubes were provided in this trench along the entire length of the dam. The depth to which the grouting was carried out varied between 20ft and 80ft, depending upon the resistance encountered to the flow of the grout.

When construction work was started the Inveruglas Water was diverted at the dam site and flowed through a concrete culvert which passed through the dam near its deepest section. This culvert can be seen in Figs. 4 and 5. Upstream of the dam fill was dumped up to the top level of the culvert to form an earth dam upstream of the foundation work, which was thus kept dry. When the construction of the dam was sufficiently advanced the culvert was concreted in; various reinforcing bars were left protruding round the edges of the culvert where it passed through the dam, and a timber stop gate was placed across the upstream end of it, after which the channel through the dam was quickly plugged with concrete. This stage of construction has been completed in the view shown in Fig. 2, where part of the diversion channel has been backfilled, the upstream part being visible on the right of the access bridge over the stilling pool.

Details of the dam are shown in Fig. 6. The buttresses are spaced at centres of 65ft and are each 26ft thick. The upstream face is a plane surface with a batter of 1 in 40 and the downstream face of the buttress is sloped at 0·8 horizontal to 1·0 vertical. The walls between the buttresses are elliptical in plan on the downstream face and at the centre of each there is a contraction gap. Low-slump concrete was specified for the construction of the dam, the mix used for the main work consisting of 3½ cwt of cement to 12 cubic feet of sand and 20 cubic feet of graded aggregates with a maximum size of 2½in (approximately a 1 : 3 : 6 mix). In the thinner sections of the dam, however, and on the upstream face richer mixes have been used.

The buttresses are concreted in two sections and the contraction gap left between adjacent buttresses is about 6ft wide. The tee-head of each buttress is concreted several lifts ahead of the stem, thus avoiding contraction cracks within the buttress itself. The concrete is poured in lifts about 3ft 6in high, panels of steel shuttering being bolted into the last completed lift and then raised as the work proceeds. Small runabout cranes are used to handle the shuttering panels, and they are lifted from one buttress to another, as required, by the cableway (see Fig. 5).

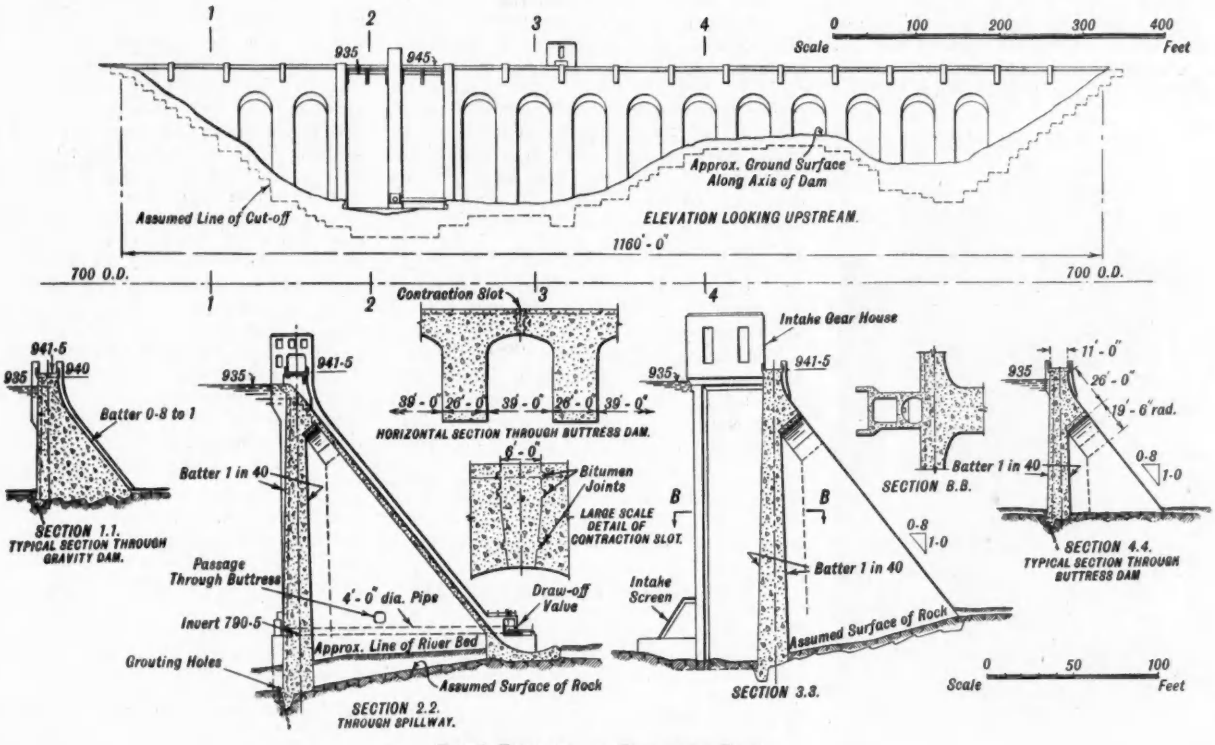


FIG. 6—DETAILS OF BUTTRESS DAM

The tee-head of each buttress is constructed with horizontal construction joints, and the buttress stem with construction joints having a slope of 1 in 6 downwards towards the upstream face of the dam, the line of corresponding joints in each part meeting at the juncture of the head and the stem. Thus the weight of each lift in the stem is thrown forward slightly on to the tee-head. The surfaces of the sloping joints in the stem are cleaned and roughened between lifts by an air-water jet and are plane; the horizontal joints in the tee-head are similarly roughened and, in addition, are keyed together with concrete spigots, 1ft high and about 8ft square, cast on the top of each lift with timber shuttering (see Fig. 5). The concrete is placed in batches of 4 cubic yards from the cableway skips, and is consolidated with immersion vibrators. The average rate of progress is about 500 yards daily.

The contraction gaps are concreted in when the buttresses are at least three months old. Fig. 6 shows the watertight construction joints provided at the surfaces of each of these gaps. A bitumen-asbestos sheet is placed round the surfaces of each of

the six chases, the gap being wedge-shaped. When the reservoir is filled the hydrostatic pressure on the upstream face of the dam acts on this wedge, and this pressure, combined with the bitumen seal, ensures watertightness.

The spillway is built in two halves, each half spanning one of two adjacent gaps between the buttresses. Each half is constructed of precast reinforced concrete slabs supported at rebates left in the buttresses; this construction may be observed in Figs. 2 and 5. There is a dispersing bucket at the bottom of the spillway, which will normally be submerged in the stilling pool at the toe of the dam, as it is in Fig. 2. A concrete lined channel leads from the stilling pool, under the twin-span bridge carrying the access road, to the natural course of the Inveruglas Water. It may be noted from Fig. 6 that the spillway head at the top of the dam is limited, the maximum being 3ft. A large amount of spilling is not envisaged in the operation of the scheme, since there is

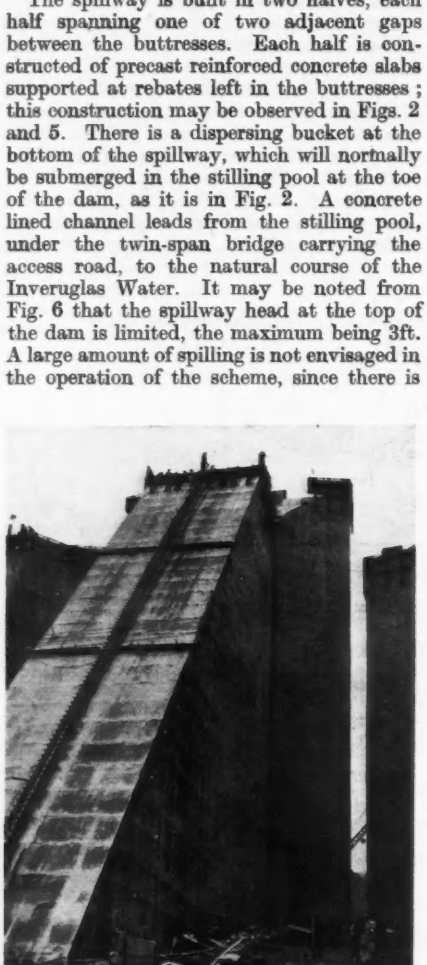


FIG. 7—CONTRACTION JOINT BETWEEN BUTTRESSES

only sufficient water for peak load generation.

The 39ft span arches over the buttress spaces were originally intended to be in concrete voussoirs erected on steel centering. This was changed on the score of speed to precast circular reinforced concrete ribs, each of 10 tons weight. Thirteen ribs make an arch and the setting of a complete arch of thirteen ribs by cableway required one day. The arch sections were each about 2ft 6in thick and rested on rebates provided at the buttress tops.

DESIGN OF DAM

The design of the Loch Sloy dam presents several points of interest and departs to some extent from earlier practice in dam design. It is thought that the form of the dam, which can be clearly seen from the various illustrations, and has been referred to earlier as a "gravity buttress" design, has not been employed before. This form is a development of the "massive buttress" type of dam, which was described by Mr. Williamson in a paper read in 1936.* It was remarked that observation of a gravity dam which had been designed for considerable uplift on the base, and was at the stage of being almost complete in a series of blocks with narrow spaces between, made it apparent that the possibility of uplift could have been reduced and savings effected without impairing the stability of the work if the upstream ends of the gaps only had been plugged, the rest of the spaces being left vacant. This point led to further considerations and the "massive buttress" design, consisting of a gravity dam built in permanently separated sections, jointed by filling in relatively narrow strips at the upstream face, was suggested. The design of the Loch Sloy dam is a further development of this idea, which has been evolved to give a bold arched appearance to the completed structure.

There are five main points in favour of the adoption of the gravity buttress dam in place of a mass gravity dam. The relatively smaller masses of the buttresses allow more rapid cooling of the concrete, the temperature rise being limited to about 30 deg. Fah. in the case of Loch Sloy, which was smaller than would have been the case in a mass dam. Shrinkage of the dam was dealt with as described earlier in this article, but it should be noted that by concreting the tee-head of each buttress in advance of the stem a provision was made for shrinkage in the width of the dam which could not have been provided so easily with a mass dam.

The elimination of water uplift on the base and horizontal construction joints was obtained by deep drilling and cementation along the line of the upstream face. Any water percolating through this cut-off would reach the voids between the buttresses under zero pressure at the outlet and not put uplift on the buttresses. By thus reducing the uplift pressures a saving in concrete resulted, and still further economy was possible owing to the increased base width, the base width of the Sloy dam being about 0·825 of the height, compared with about 0·75 for a mass gravity dam. (The wider the base of the dam, the smaller the weight that is required for stability.) The total concrete in the Sloy dam is just over 200,000 cubic yards, and it is thought that a mass concrete dam would have required at least 50,000 cubic yards more. The fifth advantage is that the maintenance and repair of a buttress dam can be carried out with greater facility than would be offered by a mass dam.

Against these advantages of the gravity buttress dam it can be said that some of the concrete must be richer, and therefore more costly, owing to increased stresses in the buttresses, and that the greater base width may give rise to increased cost of foundations. However, the rock foundation at Sloy was favourable to the buttress type, the general slope at the base being upwards in the downstream direction, thus adding substantially to the resistance to sliding. The possibility of an increase in the time required for construction must also be considered with the buttress dam, and the surface requiring shuttering is considerably larger. However, it is customary to build a gravity dam in a number of separate blocks, so that in practice there is little to choose between the two designs on this point. The use of precast arch sections, described earlier, were amongst the measures employed to keep the construction time to a minimum.

(To be continued)

*"Design and Waterproofing of Shrinkage, Contraction and Expansion Joints in Concrete Dams." Second Congress on Large Dams, Washington, D.C.

Institution of Naval Architects

JOINT SUMMER MEETING IN NEWCASTLE

No. III—*(Continued from page 32, July 14th)*

THE joint summer meeting was resumed on Thursday, June 29th, with Mr. Mungo Campbell, the President of the North-East Coast Institution of Engineers and Shipbuilders, in the chair. The first paper presented was:—

THE DESIGN OF SEAKINDLY SHIPS

By J. L. KENT, C.B.E., Member

SYNOPSIS

The qualities of a seakindly ship are enumerated, and with data obtained from experienced seamen, the effect of fullness upon the best direction for the ship to meet the weather to ensure easy handling in a seaway is deduced. The effect of the weather upon steering is discussed and the essential features of hull form for easy steering in rough weather are deduced from model experiments and observations made in ships at sea. The various motions of a vessel in a seaway are considered and attention called to those portions of hull shape and loading which produce uneasy motions of the ship in storms. The causes of shipping seas and spray are examined, and the different features in hull design that add to the quantity of water and spray taken inboard are pointed out. The reasons for eddies, back draughts and excessively high wind speeds over open decks are discussed and suggestions made which would add to the safety and comfort of passengers and crew traversing such decks in stormy weather.

DISCUSSION

The chairman recalled two ships of about 10,000 tons deadweight having the same lines; one had a cruiser stern and two holds aft of the machinery space, and the other had an ordinary counter stern with machinery aft. The ship with the counter stern was one of the best steering ships in smooth water in the Clyde, and this was confirmed during operation in West Africa. The ship with the machinery aft was by far the better ship at sea, although she was carrying ore and had a large beam. Only once had she taken a heavy sea on board.

Sir Amos L. Ayre prophesied that the paper would become a classic.

Referring to the use of a trysail aft, Sir Amos recalled that many cargo ships with the wind on the bow and the helm hard over could not move forward and had straggled from convoy. Trysails were provided and he understood that they had given very good results.

Sir Amos emphasised the importance of the vertical dimension of the rudder plate, and suggested that the upper tip of the propeller was the minimum vertical height that any rudder should be given.

He agreed with the references to the effect of pockets of dead water on vibration, and noted that Mr. Kent had detected that condition when the propeller blade was about to enter the aperture. Sir Amos pointed out that at that stage, in a ship with a four-bladed propeller and with the stern rising, two blades of the propeller were horizontal; the blade on the port side was rising with the water, and the blade on the starboard side was operating against the water at a different vertical velocity, and suggested that there was a very great deal of

difference between the port and starboard blades in those conditions.

Sir Westcott S. Abell said that questions such as the extra power needed for a winter voyage in the North Atlantic were answered mainly by rule of thumb, for as yet we knew little about the factors which gave the lowest power for rough water voyages and that most of the model tests had for their aim the lowest powers in still water, where the form below water was the chief concern.

The need to keep water off a vessel was of major importance, which meant first providing enough freeboard forward in terms of length and speed, and there must be close links between the above-water and below-water forms for at least the height of the bow wave. The conditions required could be obtained by flare or by a sloping bow helping to push the water under the ship and lessening the bow wave volume.

In rough water, reserve power was wanted in piston engines since speed and revolutions would decrease due to wave action, and no more steam, or oil in the case of diesels, could be used. There was some reserve with turbines, which could use all the steam output of the boilers and could give more power in a crisis.

He said we lacked a methodical series of experiments in rough water, and asked whether the wave maker was correct as to wave pattern within less than 5 per cent, for in order to obtain good results a study of the whole phase of motion was needed.

For a model of proper size, say 25ft long, the run for steady state must be 1250ft, which, with starting and braking distances, meant a total length of tank of 2000ft. There was no tank of that length in this country, but without such plant, tests with models would be of small value, and there was a doubt as to whether the means to measure such a complex group of effects as described were as good as they should be.

Professor E. V. Telfer felt it was the duty of the experiment tank at the N.P.L. immediately to follow on the model scale the peculiar things which had been found on the ship scale. Referring to some experiments by Hughes on a big tanker model, some of the peculiarities of which might be explained by laminar flow, he felt the subject was important and should be repeated with the trip wire check. He knew that oil tankers fitted with streamlining immediately became very much better steerers, and that increased steering ability was converted into speed.

In many vessels, he said, at the changeover point between flare and tumble-home, at about 20 per cent length from forward, seas were shipped and a continuous flare carried past the midship section produced an extraordinarily dry sea ship.

Professor K. Davidson (U.S.A.) said that within the last two years a Committee of the American Tank Conference had been established to deal with seakindliness. He noted that Mr. E. H. Watts in his paper had emphasised sea-going and sea-keeping qualities and had not mentioned tonnage; and in Mr. Kent's paper on seakindliness there was no mention of resistance. For many years he had felt that the whole science and profession of naval architecture must make up its mind to give more attention to problems of that kind. He suggested that wave-making resistance and also wave encountering at sea was much more of a barrier to the naval architect than was cavitation.

The paper was one of the very few in which the question of steering was treated as part of the whole picture of sea-keeping qualities, for one of the difficulties had been that people had attempted to deal with one element of sea-keeping, such as rolling or pitching or resistance, whereas the whole thing must be treated as an entity.

Having become interested in the question of following seas, he said that the period of encounter then became quite long, so that in a limiting case we could think of a ship as in a steady state of motion with the sea behind her. We could not deal with that situation in terms of simple moments and forces due to yaw alone, but must bring in the forces and moments due to rotary motion, and so he was a little confused by the reference to the movement of the centre of resistance with change in the angle of yaw. An angular rotation superimposed on a yaw angle affected the position of that centre tremendously and very rapidly, but he did not think one would obtain the answer by dealing with yaw angle alone.

Mr. R. W. L. Gawn said the author had presented some extremely helpful views on the requirements in ship design to improve the behaviour at sea.

In regard to steering, it was useful to note the importance attached to the shape of the underwater hull, and Mr. Gawn suggested that the requirement there was to combine directional stability with good dynamical stability of motion. The importance of the latter was brought out in a paper by Professor Davidson and Dr. Schiff, to the Society of Naval Architects and Marine Engineers in 1946, entitled "Turning and Course-Keeping Qualities," in which was given a "stability index" for some designs. A tanker form was on the stable side of the index; a cruiser and a destroyer were still more stable. That had relevance to the interesting point that ships of finer block coefficient could steer closer to the wind than could fuller forms, and navigate with easier control and smoother movement. Mr. Kent did well to stress the importance of reducing rolling motion, since the roll reacted on steering. Whilst it was advisable to design a ship with as large a rolling period as possible, that process should not be taken too far. If the rolling period were large, then the synchronous wave would be large, and the number of occasions at sea on which such waves would be met was correspondingly reduced. If the period of the ship were very large, rolling, except in very long swells, could be made very small.

The consideration of means of damping pitch was important; the reference to fins was interesting in that respect, and apart from fins the distribution of load could be of more importance than modification of shape.

Expressing surprise that freeboard had not been given greater prominence, Mr. Gawn said that, while good freeboard might not have a pronounced effect on pitch and heave, it made a major contribution to the dryness of the ship. The liners "Europa" and "Bremen" were reported to be very wet ships; their freeboard was 4·7 per cent of the waterline length. The "Queen Mary" and "Normandie" had a more favourable reputation for sea-keeping; their freeboard ceofficients were 5·6 and 5·7 per cent respectively of the length.

Captain West said it had been the practice at sea to judge the most suitable direction of ship into weather by trial and error, but the knowledge that the direction of weather increased with block coefficient would be of great value to seamen.

Ships with engines aft behaved rather differently in bad weather from ships engined amidships, and mentioned that some years ago, when a tanker was leaving an anchorage in a strong wind, it was found impossible to get the ship on to the desired course by going ahead on the engines, but when going astern, the stern went straight into the wind, despite thrust from the propeller. That might have been caused by the deflection of wind striking under the counter and then forming an eddy, giving a calm area into which the stern was naturally attracted.

Endorsing the statement that bridge erections on a stepped back deck caused back draughts, Captain West said he had been on ships where it had been impossible to keep the bridges clean owing to back draught from the funnels.

The second paper to be read on Thursday was:—

HULL DESIGN FOR LAMINAR FLOW

By J. Lockwood Taylor, D.Sc., Member

Summary

On the modern aerodynamic theory as applied in the aeronautical field, the attainment of laminar flow over a sufficient length to give an appreciable reduction in the skin friction drag depends primarily on three factors: (i) positive velocity gradient in the streamline flow along the surface, (ii) freedom from turbulence in the fluid itself, (iii) a sufficiently smooth surface finish. Reynolds' number does not enter directly, though it is known to influence the degree of smoothness required for a given length of surface. Accuracy of contour is also of importance but its effect may probably be included under (i), i.e., if the inaccuracies are not so great as to reverse the velocity gradient the flow may be expected to remain laminar. Aircraft wings have been designed for laminar flow up to full-scale Reynolds' numbers in the region 10^8, but this is not necessarily the upper limit. In ship model work, Reynolds' number has generally been considered the critical factor, but there are grounds for discarding this hypothesis and exploring the possibility of full-scale drag reduction. Methods of calculating the velocity gradient, including wave effects, are discussed, also the necessary accuracy of construction and possibility of boundary layer control. Mathematical lines seem almost essential.

Discussion

Mr. R. W. L. Gawn said the position with regard to laminar flow on ship models was rather paradoxical; model experimenters sought to avoid laminar flow on model hulls in order to achieve realistic predictions on ship performance, but they looked to the advance that might be made if only a laminar flow ship hull could be evolved. Information was largely experimental and empirical, and the co-ordinating of mathematical and theoretical work was called for.

The author had called attention to the achievement of the laminar flow aircraft wing. There, another paradox arose, since the experimenter in aerodynamics was directing attention mainly to the removal of the turbulent boundary layer, which was exactly the reverse of the approach of the ship model experimenter.

In an aircraft, it was the wing only that had been improved; the fuselage was largely in turbulent flow, so that although the total resistance of the aircraft had been appreciably reduced, the full benefit of laminar flow awaited a suitable improvement in the fuselage. The latter was a more appropriate analogy to a ship hull than was the wing. Favourable results had been obtained so far only on one or two experimental aircraft, one reason being the necessity for the surface of the wing to be finished to and maintained at a refined degree of smoothness, and Mr. Gawn quoted from a report of the Aeronautical Research Committee, R. & M. 2375, of 1950, which implied that the smoothness must be maintained in service, calling for the use of anti-fouling compositions of great efficiency. He observed that facilities for readily washing down aircraft prior to each flight were much more simple than an equivalent process in relation to ships.

Mr. Gawn said that evidence of laminar flow had been found on ship model hulls at 10 million Reynolds' number, although some models of fine form were free at 3 mil-

lion. The Reynolds' number for a 400ft ship at 20 knots was 1000 million, or 500 million at 10 knots and exceeded 2000 million for a 600ft ship at 30 knots. Thus, the gap between the Reynolds' number of the aircraft wing, 18 million, and the ship was considerable, although that between the wing and the ship model hull was comparatively moderate.

The requirements for smooth surface to stimulate laminar flow were more stringent the greater the Reynolds' number and if that were confirmed for ship values, then the requirements for a smooth ship might be extremely refined. The large Reynolds' number of a ship was conditioned mainly by the length of the ship combined with the small kinematic viscosity of water; the Reynolds' number of aircraft was conditioned largely by speed, therefore a different criterion for smoothness appeared to be called for on a ship.

Professor T. H. Havelock said the value of the paper was in directing attention again to boundary layer control.

The section dealing with correlation between wave motion and boundary layer conditions was especially interesting and needed some theoretical basis which provided a reliable numerical estimate of such a connection and of the conditions under which the interaction might become of appreciable magnitude. Dr. Lockwood Taylor had attempted an estimate with the object of delaying transition from laminar to turbulent flow, and he asked if the formulæ given for the length of the transverse wave amidships were statements of known results, were new, and whether their basis was theoretical or empirical.

Professor E. V. Telfer said the author had indicated that if turbulence were present or if the surface of the ship were rough, the whole of the work fell to the ground. Laminar aerofoils were being used in the air, at very great heights, where the air was not so turbulent as it was near the ground, and that cut out the surface ship, but not the submarine. He referred to experiments on submarine models by another worker, in which the error was at least 50 per cent, and said that Dr. Lockwood Taylor's work did tell us which models were likely to be wrong because of laminar flow.

Mr. E. P. Lover commented that the ship design problem had two facets; first, a forebody having a favourable velocity gradient had to be established and interpreted into the table of offsets, and secondly, the surface finish of the hull form had to satisfy the most exacting requirements for smoothness.

In regard to hull form there seemed to be some hope that we should be able to lay down the optimum shape of forebody for a given speed and size. The fluid condition that had to be satisfied appeared to be relatively simple, but the optimum form might not be favourable at all speeds, due to the changing character of the bow wave system and its effects on the fluid velocity gradients.

The surface finish requirement seemed to give very little hope of being satisfied, and the author mentioned a waviness tolerance of 3/100in in 10ft as being required. The aircraft designer had found that a waviness of 2/1000in in 2in was too much, so that the outlook for laminar flow in ships looked very dark when the appearance of a ship's outer bottom after a spell at sea was considered. Further progress must inevitably await the advent of a perfected anti-fouling composition.

Professor L. Troost (Holland) welcomed the purely academic paper because it gave him some valuable information applicable to the design of propeller sections.

He said that racing rowing boats, being completely smooth and operating in still water, might derive some profit from laminar flow, and the rowers would also appreciate that they should never get into the wake of a competitor, for that would produce initial turbulence and reduce the chance of gaining advantage by laminar flow. He suggested that it would be helpful to determine the initial turbulence of moving sea water.

In his reply to the discussion, Dr. Lockwood Taylor agreed with Mr. Gawn that the flow on an aircraft fuselage was turbulent, but pointed out that the problem there was not parallel with that of a ship, because an aircraft fuselage always had a windscreen and that would upset the possibility of designing it for laminar flow.

To Professor Havelock he said the expression given in respect of the velocity potential for axial symmetry was only an approximation, but it could quite easily be improved.

On Professor Troost's remarks, he said it was time that we knew something about the turbulence of sea water, for at present we knew nothing about it. In regard to rowing boats, he suggested that if we designed a racing boat for laminar flow, the oarsmen would have to "break step" to avoid induced pitching.

The final paper to be read was:—

A FURTHER EXAMINATION OF CASUALTIES TO MERCHANT SHIPS REPORTED ABANDONED, FOUNDERED OR MISSING

By Mr. C. V. Manley (of Lloyds Register of Shipping)

Synopsis

The further examination of casualties follows the fifty years survey presented in June of last year, with the object of adducing any additional information bearing upon the concentration of losses of the smaller ships. The survey is statistical, and presents the losses upon a percentage basis, and groups them in a number of ways. A number of tables and charts compare winter with summer voyages; contrast annual losses; group vessels under specific trades, types of voyage and sea areas; and link casualties with length. The paper ends with the author's conclusions deduced from the analysis as presented.

Discussion

Mr. J. W. Thurston (in a written communication read by Mr. H. E. Skinner) said that the author's conclusions showed that ships below 300ft in length were relatively less able to fulfil their objective than were the larger vessels, and the heavy losses in the United Kingdom and Northern European waters indicated that these were the worst of the waters in which those smaller ships operated. The prominent part played by coal cargoes was not surprising, for those ships were mainly full scantling, single deck, with either a raised quarter deck, or poop bridge and forecastle. With a full cargo they loaded to their marks; with lighter cargoes the freeboard was increased and in ballast the freeboard was large, and in that condition the ships compared very favourably with their larger sisters.

It was a fact that the floatability of any three-island ship could be improved by ironing out the erections into a continuous weather deck, while keeping the same overall capacity. Such ships with their increased average depth and absence of stiffening at breaks, would, for the same draught, be lighter and cheaper than present types. Unfortunately, our present tonnage rules, with their basis of cubic capacity, would penalise such departures from existing practice.

Mr. H. E. Skinner mentioned that the figures in the paper showed that, for ships not over 5 years old, sixty were lost of lengths 201ft to 400ft, and ten of lengths over 400ft. The total number of ships operating in those groups were roughly the same. So that the odds in respect of loss were 6 to 1 against the smaller ships, although in ballast, the smaller ship was no less safe than the larger ones.

Pointing out that analysis on the basis of type of ship would be valuable, he said we wanted to know the figures in relation to raised quarter-deck, poop bridge and forecastle, full scantling vessels, and the shelter-deck type; and prophesied that when that analysis was made the shelter-deck ship, with her large freeboard, would come out exceedingly well.

Mr. J. Lenaghan, commenting on the percentages of the different sizes of sea-going merchant ships to the total number owned in the world between 1921 and 1948, noted that the percentage of ships of more than 5500 tons (over 400ft) had doubled during that period, whereas the percentage of those between 2500 tons and 5500 tons (301ft to 400ft) had been halved.

The average of seasonal losses over the last 30 years was surprisingly stable, indicating that there was a certain seasonal turbulence which we had not been able to overcome, and suggesting that, in spite of the technical advances and improved methods of construction, the percentage of losses remained constant.

He asked whether there was any particular reason why the percentage of casualties for ships of 301ft to 400ft seemed rather high in the period 1924 to 1934; and noted that in that group 60 per cent of the losses were of ships carrying ore, grain and coal, and also that the percentage of casualties among ships in ballast was relatively small.

Professor E. V. Telfer, discussing the figures relating to all sizes of ships which had become casualties, drew attention to those carrying grain, coal and oil. The figures indicated that, as the size of the ships increased they became more dangerous, when carrying grain; less dangerous when carrying coal; and when carrying oil the percentages of casualties were low in the smaller ships and became higher in the larger ships. The figures suggested to him that the simple central grain divisions might not be sufficient in the large ships, whereas they might be sufficient for the smaller ships, and that the bulkheads in oil tankers might be sufficient for the small sizes, but not for the larger sizes.

Sir Westcott Abell suggested that in the case of small vessels engaged in the coastal trade the human factor came more into the equation than was the case with ships on deep sea voyages, and he urged that it should not be overlooked in the analysis of figures of losses.

Mr. Mungo Campbell, recalling the references to increased freeboard, said that during the war, when the open shelter-deckers were put down by 15in to 18in, we had been gratified by the lack of known damage which had resulted. He said he was surprised by the small percentage of losses of ships in ballast, and if we designed a ship with adequate water ballast, we were up against the tonnage rules; in the U.S.A. that did not apply.

At the conclusion of the reading of the papers, Sir Westcott Abell, on behalf of Lord Cunningham, conveyed the thanks of the Institution of Naval Architects to the President, Council and Secretary of the North-East Coast Institution of Engineers and Shipbuilders for the arrangements made for the meeting, and Professor G. Cook, the President, also expressed thanks on behalf of the Institution of Engineers and Shipbuilders in Scotland, and thanked the directors and

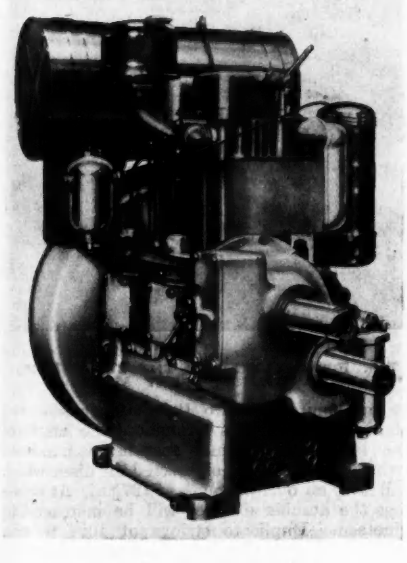
managements of the various yards which had been visited.

Visits and Excursions

On each afternoon of the meeting, an extensive series of works visits, numbering sixteen, had been arranged and several parties made interesting tours of shipyards and engine works on Tyneside, Wearside and Teesside. In additon to technical visits there was a trip on the Tyne in the Tyne Improvement Commissioners' steam launch "Sir William Stephenson"; another party was conducted on an excursion to the Roman Wall and there was a visit to Durham Cathedral and Castle. On Tuesday evening, the members of the Institution of Naval Architects and the Institution of Engineers and Shipbuilders in Scotland, together with their ladies, were the guests of the North-East Coast Institution of Engineers and Shipbuilders at a Conversazione at the Old Assembly Rooms, and on Wednesday evening the members of all three Institutions and their ladies were received by the Lord Mayor and Lady Mayoress of Newcastle, and accorded a civic welcome to the city.

A Twin-Cylinder Air-Cooled Diesel Engine

For some years Armstrong Siddeley Motors, Ltd., has been manufacturing single-cylinder, four-stroke, air-cooled diesel engines of small power ranging from 5 b.h.p. to 8 b.h.p. Numbers of these engines have been exported and they have proved an ideal prime mover for farm machinery, pumps and other apparatus. The success achieved with this engine has prompted the manufacturers to produce a twin-cylinder, air-cooled engine based essentially upon the original single-cylinder design, the air cooling giving freedom from the troubles associated with water cooling, such as freezing, blocked



Twin-Cylinder Diesel Engine

pipes and choked tanks. This larger engine is suitable for driving generator sets and for powering agricultural machinery.

The twin-cylinder engine runs in an anti-clockwise direction (looking on the flywheel end) and develops 14 b.h.p. to 20 b.h.p. over a speed range of 1000 r.p.m. to 1500 r.p.m. At 1000 r.p.m. the torque is 73·5 lb-ft, the corresponding b.m.e.p. being 92 lb per square inch, the values at 1500 r.p.m. being 70 lb-ft and 87·5 lb per square inch respectively. The cylinders have a bore and stroke of 4·25in, giving a piston speed of 708ft per minute at 1000 r.p.m. and the compression ratio is 15 to 1. Power take-off is at engine speed from the crankshaft and at half engine speed from the camshaft. Starting is by hand by means of a detachable 10in centre handle operating on the camshaft extension and by a rotary decompressor in the rocker cover, or from the flywheel end by fitting a flywheel adaptor and using a 7in. centre handle. The overall dimensions are: length without starting handle, 35in; height, 37in; and width, 24in; the weight, excluding fuel and lubricating oil, is approximately 700 lb.

The crankcase, cylinder barrels and detachable heads are of cast iron and the pistons, of aluminium-silicon alloy, have a hemispherical combustion chamber in the crown and are fitted with three compression and two scraper rings. Silchrome overhead valves fitted in the cylinder head are operated by push rods and rocker levers. A steel stamping forms the connecting-rod, the small end bush being of bronze and steel. The bottom half of the big end bearing is of steel and babbitt metal, and the top half of indium lead bronze. The crankshaft is a steel stamping, having detachable balance weights, and has three bearings of steel and babbitt metal. Fitted to the crankshaft is a cast iron flywheel of 18in diameter, weighing approximately 150 lb. A steel camshaft enclosed in the side of the crankcase is driven by spur gears giving a crank/camshaft ratio of 2 to 1.

Fuel is fed by gravity from a tank of 5½ gallons capacity to two C.A.V. single-unit plunger pumps. They are driven from the camshaft by a rocker lever and tappet and supply fuel through three-hole nozzle injectors by direct injection at a pressure of approximately 2800 lb per square inch. Air for the engine passes through a Burgess oil wash cleaner.

A force-feed oil pump built into the front main bearing cap and driven from the crankshaft supplies oil through a filter situated at the front of the engine. The oil sump has a capacity of 14 pints and the oil pressure of 40 lb per square inch is controlled by a relief valve.

The governor, of centrifugal pattern, is mounted in front of the camshaft and adjusted by a hand screw fitted on the front cover. The finned cylinder and head are cooled by air delivered through a cowl from a vaned flywheel which forms a centrifugal fan.

The fuel consumption is 0·395 lb per b.h.p. per hour at 1000 r.p.m., and 0·424 lb per b.h.p. per hour at 1500 r.p.m., and the power output at 10,000ft above sea level is 9·66 b.h.p. at 1000 r.p.m. and 13·80 b.h.p. at 1500 r.p.m., as compared with 14 b.h.p. and 20 b.h.p. at sea level.

International Union of Producers and Distributors of Electricity*

Last September a party of fourteen delegates from the central authority (B.E.A.), the area boards and the North of Scotland Hydro-Electric Board, went to Brussels to attend the eighth congress of the International Union of Producers and Distributors of Electricity—or, for short, U.N.I.P.E.D.E. This international body is an association of organisations which, in each country, primarily represent the interests of producers and distributors of electricity. It thus includes associations of electricity supply undertakings, nationalised electricity supply authorities and similar organisations; but it does not include individual supply companies, Government departments or Government bodies such as were the Electricity Commissioners. Founded in 1925, it is served by a permanent secretariat with headquarters in Paris.

Among its active members are the representative electricity supply organisations of Belgium, Czechoslovakia, Denmark, France, Great Britain, Holland, Hungary, Italy, Norway, Poland, Portugal, Sweden and Switzerland. There are also a number if adherent, associate and corresponding members, who, however, have no voting power.

U.N.I.P.E.D.E. is concerned with general economic and engineering problems of electricity supply and in particular with international transfers of electricity and the compilation of international statistics. Study committees have been established to consider particular subjects. These number, at present, nine, namely: hydro-electric generation, thermal electric generation, combined production of steam and electricity, means of increasing the capacity of networks, international interconnections, tariffs, electrical characteristics of fluorescent lamps, statistics, and electrical equipment of little-developed countries with particular reference to tropical countries. The British electricity boards are represented on all but the last.

A congress was held every second year in the country of one of the active members, but in future the congress will be held every third year. Each congress comprises discussions on technical papers, of which normally about one hundred are presented, and technical visits.

At the congress in Brussels last year about 400 engineers who work in the supply industries of various European countries assembled. As has been stated, fourteen of the delegates were from Britain and selected from the B.E.A., Area Boards and North of Scotland Hydro-Electric Board so as to provide a balance between administrative, technical and commercial interests.

Among the subjects of outstanding interest treated during the sessions were: standardisation of thermal turbo-alternator sets; combined production of electricity and steam for district heating or supply to industrial plants; economic problems encountered in the construction and most favourable operation of hydro-electric plant; political, technical, economic and legal aspects of international interconnection; means for increasing the transmitting capacity of networks by raising the voltage and employing static capacitors; general principles forming the basis of tariffs in public services and results obtained from the two main forms of domestic tariffs, i.e., two-part and block tariffs; investigation of the means for removing disturbances which may be caused by fluorescent lamps in the operation of networks; application of modern statistics in the administration of electrical undertakings (tariffs, operating faults, accidents to personnel, &c.); adaptation of methods of construction and operation of networks for the purpose of assisting electrification in underdeveloped countries, principally tropical countries.

The congress report, in two volumes of 800 pages, which presents the eighty-five papers read together with the discussions, has been published (in French), and can be obtained from the Secretary, Union Internationale des Producteurs et Distributeurs d'Energie Electrique, 12 Place des Etats-Unis, Paris (16e), price 8000 Fr. francs (approximately £8). A brochure of 200 pages containing only the contributions made to the discussions (in French) can also be obtained, price 2000 Fr. francs (approximately £2). A copy of the congress report is available at the B.E.A. Central Library, Great Portland Street, London, W.1.

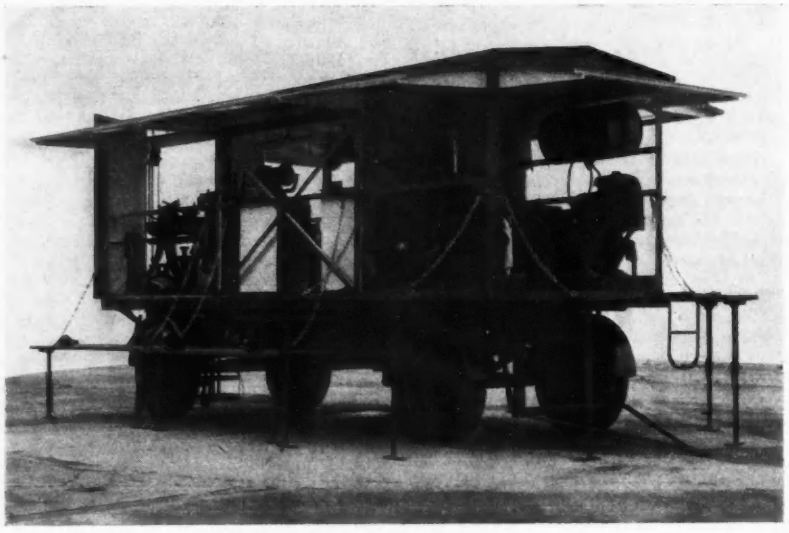
In addition to publishing the proceedings of their own congress, U.N.I.P.E.D.E. publishes a quarterly journal "Circulaire Periodique," which includes engineering and economic information about electricity supply throughout the world. This journal can be obtained from the same source as the congress report, as given above, at an annual subscription of 1500 Fr. francs (about 30s.). The journal is also available at the B.E.A. Central Library, Great Portland Street, London, W.1.

* Contributed by Mr. G. R. Peterson, Overseas Liaison Engineer, British Electricity Authority.

New Port for Paris.—The first section of the new port of Paris was recently opened when traffic entered No. 1 dock. The port is planned to cover about 1000 acres, and, when completed, will have several miles of quays and six docks, and vessels drawing up to fifteen feet of water will be able to use the port after dredging operations in the lower Seine have been completed.

A Mobile Trailer Workshop

We have received particulars of a well-equipped mobile trailer workshop which has been designed and built by Petbow, Ltd., of Sandwich, Kent, for the repair and maintenance of plant and machinery on working sites. These workshops, one of which is illustrated



MOBILE TRAILER WORKSHOP

above, have been equipped to enable skilled mechanics to deal with almost any type of mechanical or electrical failure as well as normal maintenance work.

The trailer consists of a platform of welded mild steel channel construction, covered with timber planking to which is attached a braced angle iron structure to carry the roof and sides. The roof has a double skin of "Durasteel" with an air gap to serve as thermal insulation. The upper part of each side consists of three angle iron frames hinged at the top, covered with "Durasteel" and each having a glass window. Supports are provided to keep the sides up in a horizontal position when the workshop is in use. The lower part of each side consists of three similar angle iron frames fitted with hinges below their lower extremities so that the sides can be lowered to form horizontal platforms 2ft 8in above the ground. These lower frames are planked with timber and fitted with jacks which are adjustable so they can be used as working benches. The sides can be locked in their closed positions from the inside and at the rear end is a double door. Steps which fold up inside are provided.

The trailer is divided into two sections. The workshop section contains a 6in lathe, a power hacksaw, a 1in capacity drill, an 8in bench grinder, a 30-ton hydraulic bench press, an anvil and a smiths' hearth together with a range of hand tools and gas welding equipment. The electric welding equipment and power for driving the machines is generated in the second section of the trailer. For a d.c. welding set, a 2-cylinder diesel engine drives a 275A generator, and an alternator, driven by a 10 b.h.p. diesel engine at 1500 r.p.m., produces 6kW, three-phase, 50 cycles, 400/230V current for a.c. welding purposes. All of the electric welding plant as well as a battery charging plant, is made by Petbow, Ltd.

An All-Insulated Welding Electrode Holder

Our illustration shows the general appearance of an all-insulated electrode holder designed for heavy-duty arc welding and produced by Murex Welding Processes, Ltd., Waltham Cross, Herts. The holder is stated to be suitable for welding currents from 100A to 500A, using electrodes of any size from No. 8 gauge to ¼in diameter, and it complies with B.S. No. 638.

Its jaws are made from a special alloy having good resistance to burning and spatter adherence, and are grooved to facilitate positioning of the electrode. Pressure for gripping the electrode is derived from a helical steel spring which is fitted, in its insulating shields, immediately in front of the hand guard. The spring acts on the cranked lever which pivots on a rolling contact near the jaws of the holder.

All parts of the holder are replaceable; Allen screws are used throughout and dismantling and assembly are carried out with the help of an Allen key supplied with the equipment. Both jaws of the holder take the form of replaceable bits secured by screws to the respective levers. As suggested by the illustration, the protective insulation comprises eight main items—a handle and a hand guard, two portions of insulating cover over each arm of the clamping lever, and two portions of foil provided for this particular purpose.

The complete holder weighs 24 oz and its design takes account of the need for good balance, to facilitate welding in all positions.

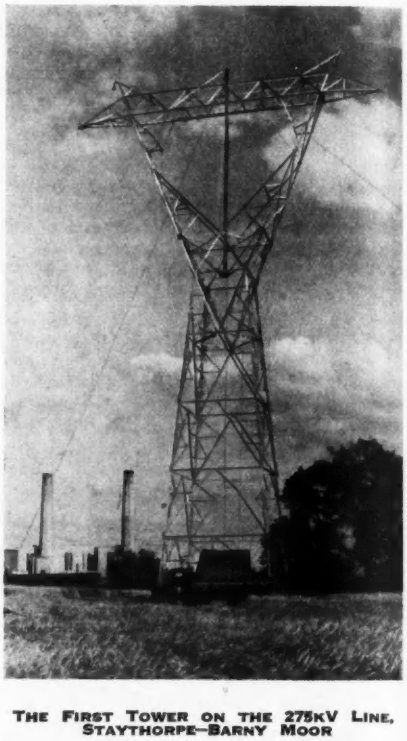
INSULATED WELDING ELECTRODE HOLDER

The holder is designed for use with 0·1 square inch T.R.S. flexible cable. Mechanical and electrical connection is obtained through the use of a duralumin cable segment and two set screws, the bared strands of the cable end having been previously wrapped with the copper cylindrical shrouding over the clamping spring.

275kV Line from Staythorpe to Barnby Moor

Two weeks ago the erection of the first tower on the Staythorpe-Barnby Moor section of the new 275kV "super-grid" was completed. This section of the line runs from Staythorpe power station to Barnby Moor and falls within the area of the East Midlands Division of the British Electricity Authority, under whose supervision the construction of the line is being carried out by British Insulated Callender's Construction Company, Ltd. Our illustration shows a view of the first tower to be erected—the straight line tower on the first span at Staythorpe power station.

The route length of this section will be 20½ miles, and, when completed, will comprise ninety-nine towers. The normal height of the straight line towers will be 85ft, and the normal span length 1000ft. There will be twin 37 0·110in steel cored aluminium conductors on each phase, separated from one another by specially designed spacers. The spacing between the phase conductors will be 32½ft, and they will



THE FIRST TOWER ON THE 275kV LINE, STAYTHORPE—BARNY MOOR

be surmounted by two 19/0·110in steel-cored aluminium earthwires throughout the length of the line. The normal suspension insulator strings will comprise eighteen 11in discs which will have an overall length of 127½in. At crossings the number of discs will be increased to nineteen. Duplicate strings of 10in tension insulators, normally each comprising sixteen discs will be fitted at angle and terminal towers, and these sets will have an overall length of 136½in. At crossings the tension sets will be increased to seventeen discs.

The towers were designed by Blaw-Knox, Ltd., and fabricated by Painter Brothers, Ltd., Hereford.

British Plastics Exhibition and Convention, 1951.—The British Plastics Exhibition and Convention will be held in London from June 6 to 16, 1951. The exhibition, the first of its size and kind, will be held in the National Hall, Olympia, and while primarily for the trade will be open also to the public.

Electrical Engineers' Tour of Dijon and Lyons

As a sequel to the recent international conference on Large Electric Systems (C.I.G.R.E.) delegates were offered the choice of three two-day tours. The first tour was to the Alps, beginning with a day at Chamonix, followed by visits to the transformer workshops of the Société Savoisienne de Constructions Electriques at Aix-les-Bain, and to the generating station at Genissiat. A similar tour of the Massif Central showed visitors something of this important district and of its hydro-electric power stations and projects for supplying some of the needs of Paris and the electrified sections of the S.N.C.F.; the programme included visits to the works on the dams of Bort-les-Orgues and Chastang and to the generating stations of l'Aigle and St. Etienne-Cantalès. By way of contrast, the third tour, to Dijon and Lyons, was mainly concerned with railway electrification and manufacture, while on the less serious side there was a reception at the Chateau du Clos Vougeot, and a brief visit to the home of Ampère at Poleymieux.

Accompanying the third party, we left Paris, Gare-de-Lyon, at 7.10 p.m. on Saturday, July 8th, and spent the night at the Hotel de la Cloche, Dijon. Sunday morning was devoted to brief tours of recently completed electric traction installations of the S.N.C.F.

The choice of Dijon as a centre for this short tour could scarcely have been bettered, for the town is an important focal point in the electrification of the line from Paris to Lyons. It may be recalled, in passing, that the first section of this scheme, envolving 159 route miles between Dijon and Laroche, was inaugurated in March, 1950, and that the next section, from Laroche to Paris, is due to be completed in about three months' time. Dijon houses the central control station for the thirteen mercury arc rectifier substations which provide traction current between Dijon and Laroche. The same building houses the centralised "telecommand" substation for controlling the traffic in and out of Dijon.

Our tour began with a visit to the traction substation at Perrigny (Dijon) where the incoming three-phase supply is received from two 60kV overhead lines which link the substations. At Perrigny the incoming 60kV lines terminate at an outdoor substation equipped with duplicate busbars and with sets of sectionalising switches for connecting either one line or the other to the busbars. In the indoor side of the substation are two 4000kW, six-phase, 18-anode mercury arc rectifiers which can be operated together or independently according to the load. The d.c. output of the rectifiers is fed at 1500kV through circuit breakers to the d.c. busbars and thence to the overhead catenary wires via the outgoing circuit breakers.

Operation of all the substations between Laroche and Dijon is automatic, control being centralised in Dijon. In the central control room the traction substation circuit is displayed in the form of a semi-circular switchboard, divided appropriately into panels from which the various switching operations can be carried out under the directions of the controller who is seated at a central desk and is in telephonic communication with the stations, train dispatchers, substations, &c.

Housed in the same building is a centralised traffic control post to allow common use of the two-track sections of the line (110km between St. Florentin-les-Laumes and Blaisy-Dijon) which would otherwise seriously limit traffic between Paris and Dijon, since the major part of the line consists of four tracks. Route control is used instead of individual control of points and signals. To provide common use the automatic block on every track consists of two double track automatic blocks with directional interlocking. From the central signal box at Dijon the operations of ten stations are co-ordinated and remote control is exercised over the electric heating system, which is designed to prevent freezing of points.

Details of the system are outside the scope of this short article. Briefly, however, the Dijon central box embodies a telephone panel of the kind generally used for traffic dispatching, in addition to a panel for centralised control. The upper part of this panel comprises a luminous diagram showing occupation of the tracks. Below the diagram are the knobs for the various control functions, with appropriate signal lamps, permitting a total of 453 different orders to be transmitted, using impulse techniques well established in automatic telephony. Actual operation of the power actuated points and protecting signals is effected from remotely controlled "all relays" signal boxes, but there is provision, alternatively, for hand operation.

After the somewhat strenuous Sunday morning tour of the railway installations in Dijon the members of the party were ready to appreciate the pleasant luncheon that was offered at Marsannay-la-Côte and the subsequent trip to the nearby Chateau Clos-Vougeot as guests of the Confrérie du Tastevin. Returning to Dijon later that evening, we went on by train to Lyons for the final stage of the tour.

The following morning we were taken to the suburb of Villeurbanne for a short visit to the workshops of the Société des Ateliers de Construction de Delle. This company specialises in the manufacture of outdoor high-voltage switchgear, and its products include minimum oil circuit breakers as well as air-blast circuit breakers. A point of interest about this self-contained factory employing 2000 workpeople, is that it manufactures its own porcelain insulators and synthetic insulating materials. We were impressed by the lay-out of the main high-voltage switchgear assembly shop, in which the units are built up in a central aisle, the sub-assemblies being fed from bays on each side; galleries flanking the central aisle accommodate light machines and small assembly work.

The test facilities at Villeurbanne are imposing. For short-circuit testing the plant comprises an alternator and outdoor transformer capable of supplying 600,000A (peak) at 250kV. The high-voltage laboratory is equipped for carrying out impulse tests at 2500kV and power frequency tests at 1500kV.

Our rapid tour of the Delle workshops was followed by a visit to Poleymieux to see the home of Ampère. The buildings are preserved as a national museum containing apparatus, documents and letters associated with Ampère and his work on the fundamental properties of electrical currents and magnetism. To do justice to the exhibits would have required almost as many hours as the minutes allowed in our overcrowded itinerary. Nevertheless, the British visitors were left with the uncomfortable feeling that Ampère deserves more credit than he usually receives for the discoveries in electromagnetism that form the basis of electrical engineering.

After lunch in Poleymieux as guests of the Ateliers de Constructions Electriques de Delle and of Câbles de Lyon we were conducted over part of the workshops and research laboratories of Câbles de Lyon, by Monsieur Louis Domenach, the company's technical director. This company manufactures a wide variety of wires and power and telephone cables using rubber, paper and synthetic insulation. Among the impressions that have survived this fleeting visit are those of the air-conditioned store room in which paper and other insulating materials are maintained under appropriate conditions of humidity and temperature; the newly-installed machines for manufacturing co-axial cables; the department in the research laboratory that is concerned with developing special cables, making up sample lengths, and subjecting them to electrical, mechanical, thermal or chemical tests to suit the particular operating conditions envisaged; and the room in the research laboratory built and equipped for making accurate measurements of interference picked up by telephone cables.

A final impression of the trip as a whole is one of admiration for the remarkable recovery made by French railways since the liberation. This progress can be expressed in terms of war damage reconstruction and technical advances; but even to the non-technical traveller, the results are apparent in terms of faster schedules and surprisingly comfortable riding.

Notes on Colonial Harbours and Wharves*

By R. D. GWYTHER, M.I.C.E.

THE following are short descriptions of some works at Colonial harbours.

LAGOS, NIGERIA

The extension of the Apapa wharfage at Lagos, Nigeria, is a good example of the design for a quay to meet modern requirements and has been evolved from the experience gained from the working of the existing wharf at Apapa. The extension (see Figs. 1 and 2) consists of a 2565ft long concrete blockwork wall, built in sloping bond, the heaviest block weighing 15 tons. The slices of blocks are keyed together by two tongues and grooves, extending for the full height of the blockwork. The foundations are on sand, a trench being dredged therein to a depth of 40ft 6in below low-water level and the wall founded on 5ft of granite rubble sealed with a layer of crushed stone. The ultimate depth alongside will be 32ft at low water spring tides; but, in the meantime, the sandbank in front of the wharf is to be dredged to give a depth of 26ft. It has been found that current action alongside the existing wharf maintains a depth of water of more than 26ft at L.W.S.T. An apron of granite with its surface level at −32·00 extends for a distance of 25ft from the toe of the wall, in order to counteract scour alongside and the action of ships' propellers.

The wall is constructed to a slight batter of 6in in its total height, so that any squeeze at the toe is taken up and the face becomes more vertical.

The superstructure of the wall is of 7 : 1 mass concrete with vertical construction joints over every third joint in the slices of blockwork. The latter will provide for any slight settlement in the blockwork and minimise the risk of unsightly cracks in the face of the wall.

The range of tide at springs is only 18in and the level of the quay surface is 9ft above low-water level, to coincide with the existing wharf. One horizontal fender of Colonial hardwood is fitted in a groove, well above high-water level, where it will be immune from the risk of destruction by marine pests. The coping is of moulded concrete and its surface is treated with carborundum grains to give a non-skid surface. Cast steel cope bollards are spaced at 65ft centres and ladders are fitted at intervals of about 195ft.

Behind the wall there will be an extensive area of reclamation of 1000ft minimum width. Sand from the excavations and other sources, such as dredging in the harbour and adjacent creeks, will be pumped in. The back and end of the reclamation area, where not protected by the lighter berth, will be formed by a rubble bank, and a transverse bank of rubble will divide the reclamation into two areas. The inner area will be reclaimed first, in order that a portion of the wharf may be brought into use as soon as possible.

A lighter berth, 370ft long and 16ft deep at low water, is provided at the outer end of the reclamation area to accommodate light craft which navigate and trade along the several inland creeks communicating with the main harbour.

On the wharf itself it is proposed to build four sheds: one double-storey shed, 487ft 6in by 100ft; two double-storey sheds, each 390ft by 100ft; and a single-storey shed, 487ft 6in by 100ft. On the reclamation area three bonded stores, a King's warehouse, 200ft by 50ft, together with stores for dangerous goods, are to be erected, and Customs, railway and shipping offices are to be provided. In addition to three lines of railway in front of the sheds and one line immediately behind them, extensive siding accommodation and a grid are to be laid. Road access will be available along the rear of the sheds, and also to areas earmarked for stacking bulk cargoes and heavy goods and to sites set apart for future development.

At the rear of each wharf-side shed a wide railway platform is provided, which, together with

* Institution of Civil Engineers. Conference on Civil Engineering Problems in the Colonies. July 4th. Abstracts.

the railway line, is protected from the weather by a light roof of 33ft span, the outer end being supported on mild steel columns.

The foundations of the double-storey sheds are carried on reinforced concrete piles, generally in groups of three, each pile being driven to a set

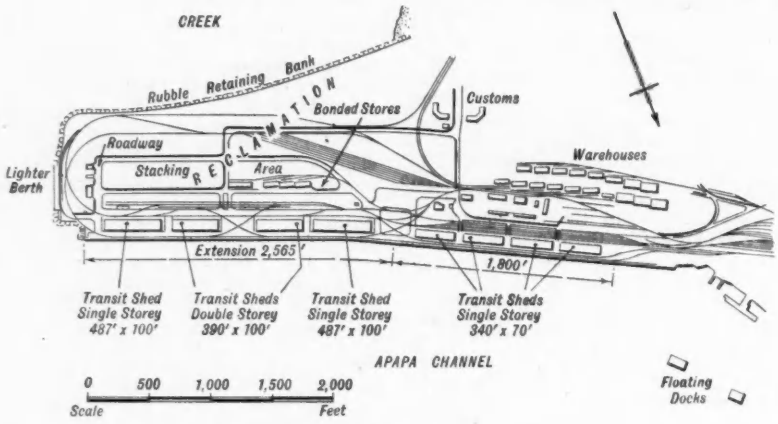


FIG. 1—*Plan of New Wharf at Apapa, Nigeria*

capable of withstanding a load of 50 tons. The ground floors will be formed of concrete having a granolithic finish and will be laid on a base of granite hardcore, well consolidated and blinded. The shed walls are built of precast concrete hollow blocks and the roof consists of asbestos-cement tiles with roof glazing.

The upper floor of the larger double-storey shed has been set apart for passenger traffic. It will contain a large hall for Customs examination and compartments for mails, parcels examination, post office, port medical officer, restaurant, waiting rooms, &c. These offices will be served by lifts from the ground floor in addition to a staircase at each end of the shed.

The installations provided for this wharf extension are typical of what is required for a modern quay with terminal railway communication dealing with a large export trade in addition to the imports required for the Colony. The question of cranage has not yet been decided, but provision has been made for allowing the existing heavy lift 25-ton crane to traverse the upstream end of the new wharf for a distance of about 150ft and crane track is being provided for this purpose.

TAKORADI, GOLD COAST

The harbour at Takoradi (see Fig. 3) was opened to shipping in 1928 and is the only deep-water harbour on the Gold Coast. Two breakwaters enclose a water area of about 220 acres and the internal development in wharfage, moorings, sheds, road and rail communications, &c., at the date of opening was sufficient to meet trade requirements at that time.

The chief works now to be constructed comprise two deep-water quays for general cargo and one for coal, built in concrete blockwork; two jetties, one for oil imports and the other for bauxite export; and 3500 linear feet of mass concrete quay with shallow-to-medium water alongside, for timber exports.

The bed of the harbour consists of a reddish sandstone, with fairly large patches of silt, most of which has been deposited since the rubble breakwaters were built. The depth below L.W.O.S.T. varies from 7ft at the inner end of the harbour to about 40ft at the entrance. The range of tide at springs is 5ft and the quay surface level is 10ft above low water.

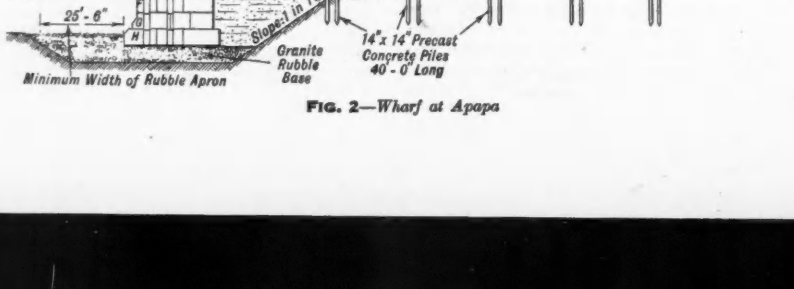


FIG. 2—*Wharf at Apapa*

above the −2·00 level with similar concrete with 1in aggregate. These walls are founded on rock, the surface of which is levelled off and keyed by a series of 2ft 6in diameter holes, 9in deep, at about 6ft intervals.

The deep-water quay wall for the general cargo and coal berths is constructed, up to a level of +2·00, of pre-cast concrete blockwork of 1 : 3 : 6 mix, laid on horizontal courses, bonded and keyed. The standard size block weighs 12½ tons. The wall superstructure is built of 1 : 2 : 4 mass concrete and faced as described for the shallow-water quay walls. Within the superstructure there will be a service subway, 6ft 3in by 4ft, to carry water and fuel oil pipes, cables, &c. The foundation for the block wall is of 1 : 2 : 4 mass concrete, deposited between shutters on the rock bottom, prepared as described above, and the concrete is screeded to form an even base to receive the blockwork. The foundation will be carefully stepped down where the depth of the rock calls for an additional course of blockwork.

The oil tanker and bauxite loading berths are to be built on the outside of the lee breakwater, the former to replace an existing arrangement of stern and stern moorings at which the tanker rides stern on to the breakwater and head to seaward; the bauxite berth will consist of an existing structure transferred from the inside to the outside of the harbour, modified and strengthened to suit the new position. Both berths are to be of the breasting block type of jetty, well fendered and buttressed to the breakwater, and the bauxite jetty will carry loading equipment which will be fed by an aerial rope-

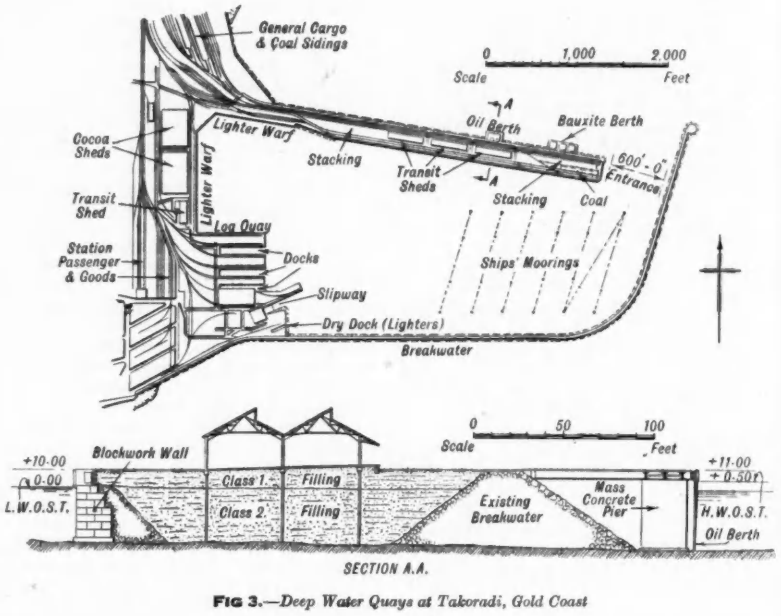


FIG 3.—*Deep Water Quays at Takoradi, Gold Coast*

The shallow water quay walls for the timber depot are formed of 1 : 2 : 4 mass concrete with 3in coarse aggregate, deposited in situ, faced

way from an ore dump and loading station on shore about 1 mile away.

FREETOWN, SIERRA LEONE

The wharf wall now under construction at Freetown (see Fig. 4) is 1200ft long with a depth of 32ft below low water sufficient for two large vessels and a smaller coasting vessel or collier. The foundations available in this case are firm sand and clay mixed with laterite boulders, which afford a good bed for a layer of 4 : 1 mass concrete, deposited under water, which varies from a depth of 18in at the front to 3ft at the back, with the bed of the prepared foundations sloped to this extent. The top of the concrete is screeded off level by divers to receive the superimposed blocks. The pre-cast 7 : 1 concrete blocks, the largest of which does not exceed 20 tons, are set in horizontal bond, the face blocks being keyed together with concrete in bag joggles. The range of spring tides at Freetown is 9ft 6in and the coping level is 16ft above low water, or 6ft 6in above high water spring tides. The superstructure is

formed of 7 : 1 mass concrete, faced with 4 : 1 pre-cast moulded concrete blocks with a flight of boat steps at each end of the wharf, ladders at intervals of 180ft and cast steel cope bollards spaced 60ft apart. A rubble bank is tipped at the back of the concrete blocks, and its rear face is blinded with crushed stone to retain the sandy filling of the reclamation.

At the inner end of the wharf there will be a considerable reclamation area, protected by a rubble bank. This area will provide sites for coal stacks and sidings, whilst at the back of the wharf an open store, 225ft deep, is obtained by cutting away some high ground.

Ample provision has had to be made for surface drainage on account of the occasional heavy rainfall and the services provided on the quay include those for fresh water and fire prevention, fuel oil for bunkers, electric light and power, telegraphs and telephones, and pipe-lines for handling palm oil in bulk.

Three sheds are provided : two single-storey sheds, 300ft by 75ft ; and a double-storey shed, 340ft by 75ft, the upper storey of the latter being used entirely for passenger, Customs, commercial offices, &c. The sheds are steel-framed structures with columns, stringers, lintels, &c, cased in 4 : 1 fine concrete. The accommodation on the upper floor is somewhat similar to that provided for the passenger shed at Lagos.

Provision is made on the quay for one 5-ton and two 3-ton electric portal cranes running on 15ft gauge rail tracks. Three lines of 2ft 6in gauge railway will be laid in front of the sheds and two at the back together with other lines, and sidings as may be required by the railway authorities. Road access is obtained by an inclined cutting through the cliff and high ground at the back of the wharf.

Mtwara Harbour, Tanganyika

At Mtwara, in the southern province of Tanganyika, there is a land-locked harbour with an area of 3¼ square miles at low water ; of this area 2¼ square miles has a depth of more than 5 fathoms.†

The wharf now under construction is 1250ft in length and is built of 6 : 1 concrete blocks set in sloping bond, the weight of each block being 50 tons. When tenders were invited for this work, in May, 1947, the contractors were given the option of coristructing blocks heavier than the 15-ton blocks shown on the tender drawings, in order to suit the plant they proposed to use, and the successful contractor adopted this larger size of block at his own request. There are five blocks in each slice of wall and these remain on the blockyard floor until required for setting, when they are conveyed to a slipway, picked up by floating plant, and set in position in the wall. The slices are bonded to each other by a 4ft 6in by 4in tongue and groove extending for the full height of the blockwork.

† See The Engineer, July 30, 1948, p. 120.

The superstructure is 6 : 1 mass concrete, faced with 4 : 1 moulded concrete blocks with the coping level 18ft above low water ; the depth of water alongside is 32ft at low water spring tides and the foundations are protected by a rubble apron extending about 25ft from the face line of the wall.

The wall is backed for the full height of the blockwork with limestone rubble, the rear slope of which is sealed with a coating of fine rubble. The ground at the back of the foreshore rises slightly and is excavated to supply filling for the reclamation of the foreshore. The area to be excavated and reclaimed is about 46 acres in extent, and railway sidings, sheds and other port facilities will be established upon it.

The development of Southern Tanganyika will undoubtedly result in extension of the harbour facilities, but this may take some years. The territory, however, is fortunate in possessing a fine sheltered harbour, at Mtwara, capable of almost unlimited expansion.

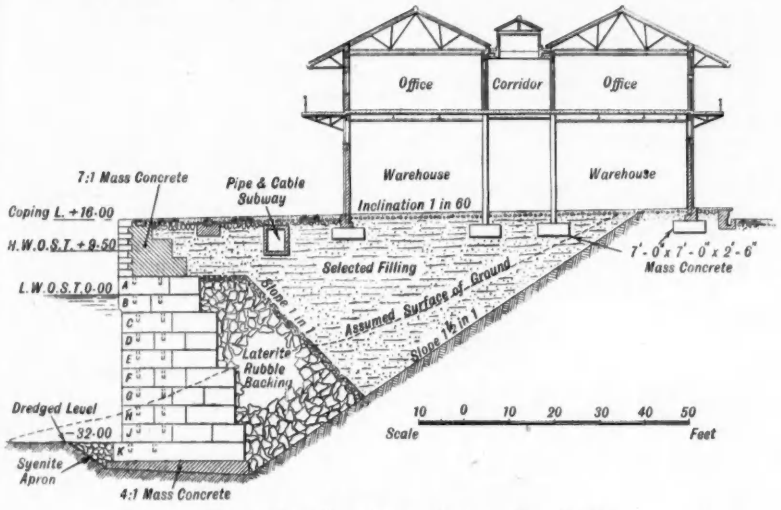


Fig. 4—*Deep Water Quay at Freetown, Sierra Leone*

A Beta-Ray Thickness Gauge

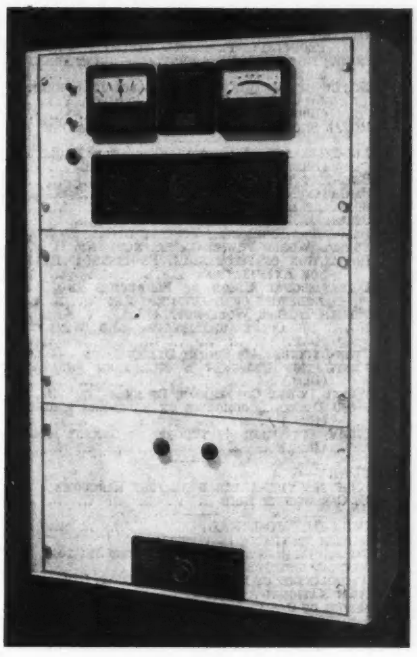
Recent developments in the use of radio-active isotopes produced in the atomic pile at Harwell have been applied to measuring and controlling the thickness of metal foils during manufacture. Broadly, the principle is that radiation is reduced or stopped by a material, such as copper or aluminium placed in its path. The "stopping power" is roughly proportional to the weight of the material in the path of the radiation. Therefore, by providing an accurate means of measuring the change in radiation falling on a detector, an indication can be obtained of the precise weight per unit area of the interposed material.

We learn that the Baldwin Instrument Company, Ltd., Dartford, Kent, has been using similar techniques for many years in the measurement of X-rays and other medical applications. Now that radio-active isotopes are available from the atomic pile the relatively costly X-ray plant can be dispensed with in making industrial measurements of the kind envisaged in this article. Sources are available to give different kinds of radiation and a choice can be made to suit any particular requirement.

For measurements on metal foil and similar materials, Beta-ray emitters are more suitable than X-ray emitters, and, being less penetrating, can readily be rendered safe to use in industry. No radio-activity is induced in the material passing through the gauge and the material remains unchanged by the process.

The new Baldwin radiation gauge for metal foil consists, essentially, of a source of radio-activity in a safety container mounted an inch or two away from the foil ; an ionisation chamber is mounted on the opposite side of the foil and at a similar distance from it. The distances between the foil and the source and chamber respectively are not critical and a considerable movement of the foil between the two can be tolerated. The speed at which the foil passes through the gauge does not affect the reading.

There is an electrical connection from the ionisation chamber to the electronic part of the gauge, for which the operating power comes from the a.c. mains. A typical industrial



Beta Ray Thickness Gauge—Industrial Model

electronic unit for thickness measurement is illustrated herewith. Normally, the instrument carries two indicators, one giving the weight per unit area, and the other showing, accurately, variations above and below a preset standard. The controls below the indicating meters comprise a selector switch and a knob for varying the sensitivity, while the right-hand knob provides the means of making "standard" settings preparatory to making comparative measurements. An "on-off" switch is mounted near the base of the unit. The makers state that the output of the gauge is sufficient to operate recording instruments or controllers.

Technical Reports

Electrolysis and the Bond Strength of Reinforced Concrete : The Effect of Direct Current : Supplementary Report. By G. Mole, Ph.D., F.Inst.P. The British Electrical and Allied Industries Research Association (Ref. O/T6). Price 3s., postage 3d.—The report describes further tests on specimens referred to in an earlier report, Ref. O/T2. The results confirm that a greater increase in bond strength is achieved by long-term electrolytic treatment than was shown after short-term treatment. By prolonging the electrolytic treatment over sixteen months a 29 per cent increase in bond strength was achieved. Alternatively, electrolytic treatment for fourteen days followed by storage for twenty months gave an increase in bond strength of 22 per cent. Neither procedure can, however, be regarded as satisfactory for strengthening concrete by treatment during manufacture.

The Time Involved in Fast Electronic Processes in Amorphous Dielectrics. By J. O'Dwyer. The British Electrical and Allied Industries Research Association (Ref. L/T220). Price 3s., postage 3d.—A theoretical discussion is given for the times of processes which involve only electrons in the conduction levels and in shallow traps of an amorphous dielectric in the presence of an electric field. A simple model is considered in which there is a conduction band and a series of equispaced impurity levels below it. The processes considered are then found to be sensibly complete in a time of 10^{-10} sec or less.

THE ENGINEER

JULY 21, 1950

VOL. CXC No. 4930

Contents

THE ENGINEER, July 21, 1950 PAGE

LEADING ARTICLES—
REPORT OF THE NATIONAL COAL BOARD 68
PASSING OF THE DESTROYER 68

SPECIAL ARTICLES—
DYNAMIC BALANCING AND ITS APPLICATION TO PRODUCTION PROBLEMS. (Illus.) 54
INSTITUTION OF NAVAL ARCHITECTS—JOINT SUMMER MEETING IN NEWCASTLE. No. III 60
NORTH OF SCOTLAND HYDRO-ELECTRIC SCHEMES. No II: THE LOCH SLOY PROJECT, PART I. (Illus.) 57
ROYAL SHOW AT OXFORD. No. III. (Illus.)... ... 70

ALL-INSULATED WELDING ELECTRODE HOLDER. (Illus.) 64
BETA-RAY THICKNESS GAUGE. (Illus.) 67
CANADIAN NATURAL RESOURCES SURVEY... 56
CONSTANT LEVEL OILER. (Illus.) 75
CYLINDER BENDING PRESS. (Illus.)... 75
ELECTRICAL ENGINEERS' TOUR OF DIJON AND LYONS 65
FOURTH WORLD POWER CONFERENCE. No. II ... 76
INSTITUTION OF MECHANICAL ENGINEERS: RULES FOR EXAMINATIONS 73
INTERNATIONAL UNION OF PRODUCERS AND DISTRIBUTORS OF ELECTRICITY 63
MOBILE TRAILER WORKSHOP. (Illus.) 64
NOTES ON COLONIAL HARBOURS AND WHARVES. (Illus.) 65
TWIN-CYLINDER AIR-COOLED DIESEL ENGINE. (Illus.) 63
VENTILATION UNITS AT BEEVOR IRON FOUNDRY. (Illus.) 74
WORLD POWER CONFERENCE DINNERS 70
0-6-0 DIESEL LOCOMOTIVE ON SOUTHERN REGION. (Illus.) 73
275KV LINE FROM STAYTHORPE TO BARNBY MOOR. (Illus.) 64

OBITUARY—
ENGINEER VICE-ADMIRAL SIR JOHN KINGCOME ... 69
H. CARTWRIGHT REID 69

A SEVEN-DAY JOURNAL 53
BRITISH STANDARDS INSTITUTION
CAISSON SINKING AT USKMOUTH POWER STATION
CENTRAL LINE JUBILEE
CHAIRMANSHIP OF BABCOCK AND WILCOX, LTD.
FIRST NATIONAL AIRWAY
SCHOOL OF GAS TURBINE TECHNOLOGY

NEWS AND NOTES—
BRITISH PATENT SPECIFICATIONS. (Illus.) 81
BRITISH STANDARDS INSTITUTION 72
CONTINENTAL ENGINEERING NEWS. (Illus.) 78
CONTRACTS 82
FORTHCOMING ENGAGEMENTS 82
FRENCH ENGINEERING NEWS 80
INDUSTRIAL AND LABOUR NOTES 79
NOTES AND MEMORANDA 80
PERSONAL AND BUSINESS 82
TECHNICAL REPORTS 67

NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

For Subscription Rates, see page 2 of Advertisements.

THE REPORT OF THE NATIONAL COAL BOARD

IN the introduction to the third annual report of the National Coal Board it is rightly and conclusively stated that the immediate tasks of the Board are the production of more coal, the enhancement of exports, the lowering of costs, and improvement in the quality of the coal. So the work of the Board must be judged according to the extent of its achievement of the tasks it has set itself. The results obtained in 1949, though they indicate some improvement on those of the previous year, leave, we think, much to be desired. How much further improvement is needed is revealed by making a comparison with the last complete pre-war year, 1938. The output in 1949 at 202,700,000 tons fell short of the 207 million target, and though it showed an increase of 5 million tons over 1948, it was not equal to the demand. By comparison, in 1938 the output was 227 million tons. Furthermore, although the output per man-shift, calculated over all workers at the collieries, was 1·16 tons, the highest since 1935–7, we cannot but wonder why, in the face of all the mechanisation which has been carried out in the intervening years, it should not have reached and surpassed the figure for 1935–7, and should only have exceeded the figure for 1938 by 0·02 tons. The output per man per annum in 1938, too, was above that for 1949, owing to the fact that in 1949 the absenteeism was 12·34 per cent as against 6·44 per cent in 1938. Well might Mr. Ebby Edwards, a former secretary of the mineworkers union and now labour relations member of the N.C.B., shock the miners' leaders at the conference at Llandudno on July 5th of this year by his statement that though the miners receive six days pay if they work five days in the week, thousands of them were not earning this bonus. Never have the miners been in receipt of higher wages than at present, for those working underground earned a weekly wage (the average of men and boys) of £9 5s. 9d., and those of them who were piece workers earned more than that.

There has, for some years, been much adverse criticism of the quality of coal produced. Lord Hyndley, in a statement covering the report, says the reasons why the coal is dirtier than it used to be "are, I think, well known; they are 'long-term' reasons and cannot be disposed of overnight." One is puzzled to know what meaning to attach to this somewhat cryptic statement. We would have liked to know more precisely, what are the reasons, and more, surely, how they are to be met. The condition of much of the coal now being put on the market is still deplorable, and this state of affairs has been much more in evidence over the last three years than previously. It may be accounted for, in part, by the admixture of opencast coal, which in 1949 amounted to 12,400,000 tons, and also to the more extensive mechanical cutting and loading of the coal at the face. But surely more care could be exercised in seeing that stone is not loaded with the coal. The operating profit of the collieries at £29·9 millions shows an advance of £13·2 millions over the previous year, but we need to remember that in respect of both years the profits were gained as a consequence of the excessively high price of the coal sold; and in 1949 especially, a high price was obtainable for coal exported, amounting, in the latter year, to roughly £1 a ton on 20 million tons above the home prices. As competition from Poland and the Ruhr is growing, it is doubtful whether this high comparative level of prices will be long maintained. Another disquieting feature is this, that even with the high prices at present obtainable both in the home and the foreign markets—the average is over 170 per cent above that of the year 1938—the collieries of Cumberland, Northumberland, Durham, South Wales and Monmouthshire, Forest of Dean, and Bristol and Somerset were worked at a loss. The profit earned by the Board was chiefly derived from the coalfields of Yorkshire and the East and West Midlands. There appears to be only one way by which the coalmining industry of our country can be put upon a sound business basis; and that is by such a substantial reduction in the cost of production, a cost at present 180 per cent above the figure for 1938, as to permit the coal to be sold at a price that will allow our coal-using industries to be carried on successfully in competition with other countries while still enabling us to export coal at a profit. Nearly £9 millions of the £61 millions to be devoted to the carrying out of major schemes of development was spent by the Board in 1949. But whether this expenditure and that to be devoted to 'long-term' projects, will result eventually in the desired reduction in the cost of production remains to be seen.

We welcome the account of the research work being carried out under the auspices of the Board with regard to the health and safety of miners, the better use of coal, and mine engineering. But undoubtedly roof control continues to be one of the major problems facing the mining engineer. Falls of ground constitute the most fruitful source of fatal accident in mines. Much remains to be done in the study, and control, of the forces operating on the roof, especially at the coal face. Useful work has been carried out in this direction in Germany and the United States of America.

THE PASSING OF THE DESTROYER

AMONG those who listened to the speech of Vice-Admiral Denny, the Third Sea Lord, at the launch of H.M.S. "Diamond"—the third of the "Daring" class to be launched—at Clydebank last month, probably few appreciated the full significance of his statement that this vessel, and the other seven destroyers of her class now building, would be the last ships to be recognised as conventional destroyers. It was, in fact, a statement of Admiralty policy which is the logical outcome of its decision and of the decision of the United States Navy Department, to place all but one of their battleships in reserve. Indeed, while the Admiral was speaking at Clydebank, the battleship "King George V," dehumidified and with her guns sealed, was about to leave Portsmouth in tow of three tugs for her permanent anchorage in the Gareloch. Like buses and motor-cars, ships are built to perform a definite function—the liner to convey her passengers as comfortably and as quickly as possible to their destination, the warship to do her part in controlling sea communications. And in announcing that no more of the conventional type of destroyer would be built, the Third Sea Lord was emphasising, not so much the end of a phase of warship development but the marked change which has now taken place in the hitherto accepted methods of conducting war at sea. For it is clear that the functions which destroyers were originally intended to perform have, at any rate for the time being, passed into the realm of history.

The older generation may still be able to recall the alarm caused in this country in the 'eighties of last century by the sudden appearance of the small French torpedo-boat, which was to blow the battleship out of the water—the battleship whose guns had for centuries been the final arbiter of battles at sea. The counter, however, was not long in coming in the larger and more seaworthy torpedo-boat destroyer. The latter, in her turn, soon entirely replaced the torpedo-boat as a real and effective threat to the battleship, both by day and by night. By day, destroyer flotillas, each of some nine ships, approached the opposing battle fleet, while it was engaged by the guns of their own fleet, from three directions at high speed, to fire their torpedoes at the closest practicable range and thus make it

extremely difficult for the enemy fleet to avoid all the torpedoes without completely disorganising his own gunfire. By night, the flotillas made use of darkness as a cover for surprise attacks. None the less, it is of interest to note that until the Battle of Jutland in 1916 it always remained the primary object of the British destroyers to prevent the enemy flotillas from interfering with the gun duel between the two opposing battle fleets. Inevitably, each naval power competed with other naval powers in building larger and more powerful destroyers, since there was no international agreement limiting their size, as in the case of battleships and cruisers. Indeed, the "Diamond" and her seven consorts now building are almost in the pre-war light cruiser category, with a displacement of 2600 tons, a main armament of six 4·5in guns, elaborate fire control arrangements and electric galleys and laundries, and other amenities for the crew. But with the temporary eclipse of the battleship—temporary, because her function is determined by our potential enemies, who, at the present time neither possess nor are building ships of equal fighting power—there is no need to continue building the type of ship required to attack her. To say so is not to lose sight of the many and varied ancillary duties which destroyers have been called upon to perform since the beginning of the century. Fast and relatively small vessels with an effective gun armament will still be needed to form part of task forces as escorts to aircraft carriers and other large ships, to act as maids-of-all-work, to be despatched here, there and everywhere where trouble arises and, last but not least, to provide the best kind of training for officers and men in the art of seamanship. The development of the submarine, however, into a genuine submersible capable in the near future of proceeding at high speed submerged at any desired depth, and the more general application of the atomic charge to naval weapons which is to be anticipated, have necessitated the building of a different type of vessel for these "general purpose" duties—a smaller vessel than the modern destroyer, with equally good sea-keeping qualities, but with fewer guns, a more powerful anti-submarine armament, and much greater endurance.

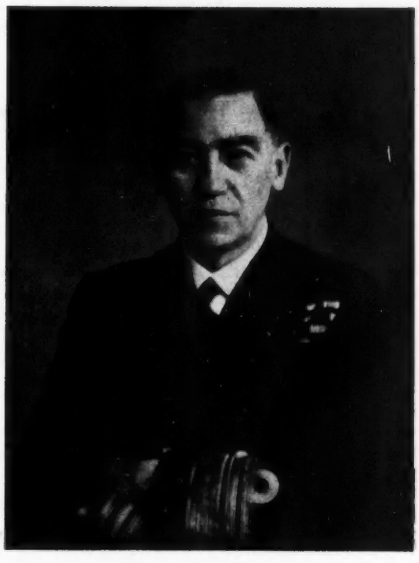
Recent Government announcements in Parliament hold out hopes that a prototype vessel of this kind—economical to build and to maintain—has been designed and will shortly be laid down, as the start of a replacement programme for our 20-knot war-time frigates. Large numbers of these ships will be required in view of the dispersal of important warships and merchant ships made necessary by the threat of the atomic weapon. Moreover, hostile submarines may have to be sought in many outlying areas, unfrequented by shipping, if, as seems likely, it becomes possible for them to fire atomically-charged guided missiles on the centres of our population. No details are available of the hull and machinery of the prototype vessel, but the experiments which the Admiralty has been carrying out since the war with aluminium hulls and gas turbine engines may give some indication of her general characteristics. Canada has already laid down three fast anti-submarine vessels, which, it is believed, are to be facsimiles of this Admiralty-designed ship. Meanwhile the British, Australian and United States navies are giving practical proof to their belief that the day of the destroyer is over by converting some of their existing destroyers for anti-submarine work, and many more will be taken in hand for conversion if these compromise ships prove successful. They are to be given extra fuel tanks and the number of anti-submarine weapons will be increased, at the expense of their gun and torpedo armament. It is, however, essential to bear in mind that if destroyers are expensive to build and to maintain and are unnecessarily heavily armed for anti-submarine operations, they are none the less very effective ships for detecting and destroying submarines. To convert them into anti-submarine "frigates" will thus provide no increase in the small number of vessels now available in the Royal Navy to deal with the modern type of submarine with fast underwater speed.

Obituary

ENGINEER VICE-ADMIRAL SIR JOHN KINGCOME

It is with regret that we record the death, on July 15th, at the early age of sixty, of Engineer Vice-Admiral Sir John Kingcome, K.C.B., who retired in 1947 from the post of Engineer-in-Chief of the Fleet, after forty years' service in the Royal Navy.

Sir John was born in 1890 at Hastings, Calcutta, and he entered the Royal Naval Engineering College, Keyham, in 1905 as a cadet, after taking first place in the examination list. Three years later he went to the



Sir John Kingcome

Royal Naval College at Greenwich for further training. As an Engineer Lieutenant he served on board H.M.S. "Temeraire," and subsequently saw action at Jutland while Senior Engineer in the cruiser H.M.S. "Phaeton." After further sea service in H.M.S. "Commonwealth" and the destroyer H.M.S. "Rapid," Sir John joined the Admiralty Board of Invention and Research under the late Lord Fisher, and in 1919 he returned to the Royal Naval College, Greenwich, as assistant to the Professor of Marine Engineering. Before joining the Engineer-in-Chief's department in 1925, he served in H.M.S. "Hawkins" on the China station, and was promoted to Engineer Commander. During the next few years Sir John was engaged on work concerning propelling machinery for destroyers and he then joined the cruiser H.M.S. "London" on commissioning, to serve in the Mediterranean as Squadron Engineer Officer. Shortly after his promotion to Engineer Captain in 1935, he was appointed assistant Engineer-in-Chief of the Fleet, and in 1939 was again at sea serving as Senior Engineer Officer in the battleship, H.M.S. "Nelson," and later in the battleship H.M.S. "Warspite" on the technical and administrative staff of the Commander-in-Chief, Home Fleet, transferring to the battleship H.M.S. "Rodney" in the following year. He saw action in the war and was mentioned in dispatches in 1940 for his part in the Norwegian operations. In 1941, Sir John was promoted Engineer Rear-Admiral and became Deputy Engineer-in-Chief the following year. Three years later, he succeeded Engineer Vice-Admiral Sir Frederick R. G. Turner, as Engineer-in-Chief of the Fleet. This appointment, of course, is the highest to which Engineer Officers of the Navy can aspire, and demands of the holder professional skill, wisdom and wide understanding, all of which attributes Engineer Vice-Admiral Kingcome, during his short tenure of office, proved that he possessed. He retired in 1947.

Sir John was always interested in technical matters, and was a valued member of the Institution of Naval Architects, which he joined in 1926, being elected a member of council in 1946. He was a member of the Institute of Marine Engineers from 1942, and served as vice-president for the Royal Navy until 1945. He was elected to membership of the Institution of Mechanical Engineers in 1944, becoming a member of council in 1945. To that Institution he presented the 21st "Thomas Lowe Gray" lecture in 1949, on "Marine Engineering in the Royal Navy, 1922 to 1947." Sir John was made a C.B. in 1943 and created K.C.B. in 1946, in recognition of his services to the Navy.

H. CARTWRIGHT REID

We regret to have to record the death of Mr. Herbert Cartwright Reid, a former Deputy Civil Engineer-in-Chief at the Admiralty, which occurred, suddenly, at Harpenden, Herts, on July 16th. Mr. Reid, who was born on November 7, 1864, was educated at Kirkby Lonsdale Grammar School, and was subsequently trained as a civil engineer.

Mr. Reid entered Admiralty service in 1889 as Assistant to the Superintending Civil Engineer at Pembroke Dockyard. After promotion, he served at Halifax (Nova Scotia) and Esquimalt (British Columbia), and, later, at Chatham and London. Following his appointment as a Superintending Civil Engineer in 1903, Mr. Reid was responsible for important dock and harbour work carried out at Malta, and from 1908 to 1911 was Superintending Civil Engineer at Chatham Dockyard. His next task was to supervise construction work at Rosyth Dockyard between 1911 and 1917, and a year later he was appointed Superintendent of Auxiliary Works at the Admiralty. Following the first World War Mr. Reid was

entrusted with the supervision of reconstruction work in the Belgian ports, and was given the rank of Lieut.-Colonel, Royal Marine Engineers. In 1919 he acted as consulting engineer to the Calcutta Port Trust, and towards the end of that year became Deputy Civil Engineer-in-Chief at the Admiralty, a position which he occupied until 1921. From then until his retirement in 1928 Mr. Reid was Engineer-in-Chief of Vizagapatam Harbour, India. Mr. Reid was a member of the Institution of Civil Engineers. He was created C.B. in 1917.

World Power Conference Dinners

NEARLY 400 delegates to the fourth World Power Conference attended a dinner given by the British Electrical and Allied Manufacturers' Association, at the Connaught Rooms on Wednesday, July 12th. Sir George Nelson, President of the Association, proposing the toast of the "World Power Conference," reminded the guests that the development of the earth's sources of power had taken place over some 200 years, which was but a minute part of man's history. Although much had been done in those 200 years man's work, so far, had merely scratched the surface of the resources constantly available from the influence of solar light and heat. Sir Harold Hartley, who responded, as chairman of the conference, developed the same theme of men's efforts to harness the available natural power resources. He pointed out that the total energy resources developed by man represented only 0·002 per cent of the energy available in solar radiation. It followed that a study of methods of utilising solar energy might be worth while on the grounds that, if 0·001 per cent of the total could be tapped, world power resources would be increased by 50 per cent. The toast of "The Guests" was proposed by Mr. G. Leslie Wates, chairman of Council of the BEAMA, and the response was made by the Right Hon. G. R. Strauss and by Monsieur Ernest M. Mercier, Vice-President of the International Executive Committee of the World Power Conference. On the following evening, Thursday, July 13th, the conference banquet was held at Grosvenor House, Park Lane, under the chairmanship of Sir Harold Hartley, F.R.S. It was a distinguished gathering attended by some 1600 delegates and guests. After the toast of "H.M. the King" and of "The Patrons" (Their Royal Highnesses The Princess Elizabeth and the Duke of Edinburgh), the chairman called for the toast of "The Heads of the Member States." The Lord President of the Council, Mr. Herbert Morrison, then proposed "The Fourth World Power Conference," describing the conference as one of the most successful experiments in international co-operation. Its International Executive Council, he said, was a remarkably unanimous body. Mr. Morrison went on to say that the increased use of power and rising standards of living went hand in hand, and there was always the danger that we might be neglecting new discoveries. But, he added, it was essential to remember that man should be the master and not the slave of power. Responses were made by Monsieur Ernest Mercier and Shri A. N. Khosla, Vice-Chairmen of the International Executive Council of the Conference, both of whom paid tribute to the work of Sir Harold Hartley and to the vision of the late D. N. Dunlop under whose direction the World Power Conference developed so rapidly in strength and influence. "The Organising and Other Working Committees of the Conference" was proposed by Ir. G. J. T. Bakker, representing the Government of the Netherlands, and was acknowledged by the chairman. The final toast was that of "The Overseas Visitors," proposed by Mr. P. J. Noel-Baker, Minister of Fuel and Power, and replied to by Mr. William E. Warne, of the United States Government, and Dr. W. Borgquist, the official delegate of the Swedish Government.

The Royal Show at Oxford

No. III—(*Continued from page 44, July 14th*)

WE conclude in this article our description of some of the implements and machinery which were exhibited at the Royal Agricultural Society's recent Show at Kidlington, Oxford. It has now been announced that next year's Royal Show will be held at Cambridge from July 3rd to 6th.

JOHN ALLEN AND SONS (OXFORD), LTD.

In earlier years of the Royal Show, steam ploughing tackle was regularly among the principal exhibits in the machinery section.

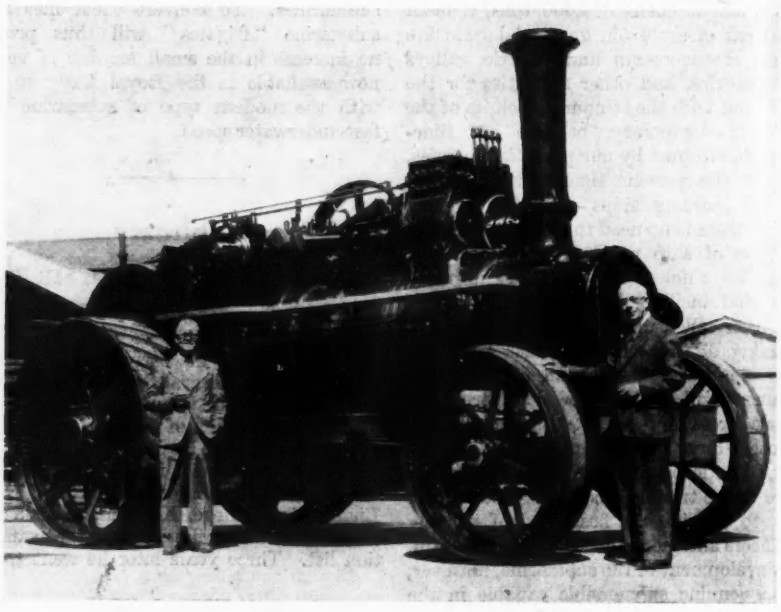


FIG. 14—12 H.P. STEAM PLOUGHING ENGINE—ALLEN

There were many visitors to this year's Show who found pleasure in being reminded of the "steam cultivation age" by the appearance of a ploughing engine, in motion, on the stand of John Allen and Sons (Oxford), Ltd., Cowley. This engine, which is a 12 h.p. compound working at 200 lb pressure, is the remaining one of a pair built by the firm in 1913, when it was known as the Oxfordshire Steam Ploughing Company. Between 1908 and 1913 two pairs of these engines were built for ploughing and other cultivating operations on the double engine cable principle. At this distance it is interesting to recall that a great deal of the construction work was carried out by hand, including the boring of the cylinders from the rough casting, a task, we were informed, which took about 2¼ hours for one pass-through. The photograph reproduced in Fig. 14 shows the engine, which is a striking example of craftsmanship. The engine was designed by Mr. George Harley, who may be seen on the right of our engraving, and Mr. Arthur Anderson, shown on the left, was responsible for a large share of the construction work. Mr. Anderson was then nineteen and in the last year of his apprenticeship with the firm of which he is now the managing director. We were happy to learn that the firm intends to keep the engine as a "museum piece."

Examples of the firm's present-day products were also on view at Oxford. They included the self-propelled motor scythe, which was described in THE ENGINEER of July 4, 1947. The latest model makes provision for the attachment of a trailer seat and a hayrake. The seat is mounted on pneumatic-tyred wheels and the rake is fitted to a bracket on the seat pillar. Alternatively, the trailer wheels can be easily removed and replaced by a four-section roller, which can be assembled on the axle.

DAVID BROWN TRACTORS, LTD.

Examples of the "Cropmaster" and "Trackmaster" tractors were shown by David Brown Tractors, Ltd., Meltham, Huddersfield, together with various implements which are now in production as attachments to them. One of the latest of these implements is a single-furrow one-way plough, which is illustrated in the engraving, Fig. 15, mounted on the "Cropmaster" diesel tractor. This tractor, it may be recalled, is equipped with a David Brown diesel engine, with four cylinders, 3½in bore by 4in stroke, which is capable of a maximum output of 25 b.h.p. at 1400 r.p.m. In the design of the one-way plough consideration has been given to varying soil conditions both at home and overseas. It is a single-furrow implement fitted with 16in deep digger bottoms, and the independent knife coulters and forward skims are adjustable fore and aft by means of sliding clamp plates. To give positive depth control there are two rubber-tyred land wheels, which are adjusted by "Solidbloc" shock-absorbing stops running in slots on the wheel arms. The plough is finely balanced and is turned over by means of a change-over control lever operated from the tractor driver's seat. The overall length of the plough is 6ft 4in and its total weight 8 cwt.

In Fig. 16 there is reproduced a view of the "Sapper" earth mover, which was exhibited by its makers, Bomford and Evershed, Ltd., Evesham, Worcs, as well as by David Brown Tractors, Ltd. This implement was introduced originally about seven years ago for attachment to the Fordson tractor, and its adaptation for use with the "Cropmaster" is a recent innovation. The "Sapper," which has been designed to shift earth or any loose material, is equipped with detachable digger tines, by which

the soil can be loosened before the actual shifting operation takes place. The blade, which is 5ft wide by 2ft deep, has a high carbon steel cutting edge and a slipper lifting device, working in conjunction with the tractor power lift, permits the blade to be easily raised when under a stalling load. Heavy duty coil springs assist the return of the blade to the working position. The power lift raises the blade independently of the slippers, after the first few inches, to a height of 15in. An important part of tractor-mounted earth-moving equipment is the sub-frame, and in the case of the "Sapper" it has been so designed that the full thrust of the blade is taken on the rear axle of the tractor. The blade itself is detached by removing four split pins and two control rods, leaving the sub-frame in position. The power lift is then uncoupled and is thus available for use with other mounted implements, the only restriction being a minimum ground clearance of 9½in.

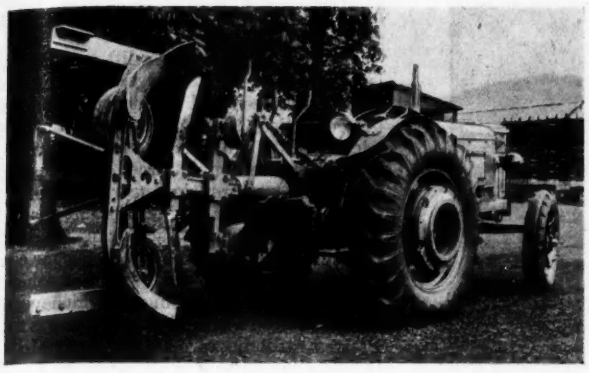


FIG. 15—SINGLE-FURROW ONE-WAY PLOUGH—DAVID BROWN

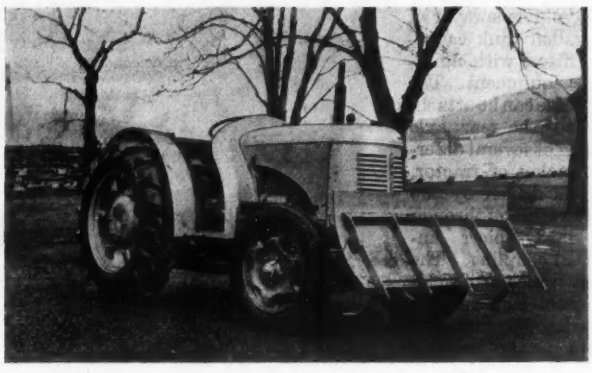


FIG. 16—"SAPPER" EARTHMOVER ON "CROPMASTER" TRACTOR—BOMFORD AND EVERSHED

FISHER HUMPHRIES AND CO., LTD.

Among the exhibitors of forage handling machinery was Fisher Humphries and Co., Ltd., Atlas Works, Pershore, Worcs. The forage harvester, illustrated by the engraving Fig. 17, is entered for the Royal Agricultural Society's forage machinery competition, the trials for which are now in progress. The machine, which is described as a cutter-chopper-loader, can either cut or pick up the crop from a field before loading it into a trailer for conveying to a silo or drier. When it is fitted with a conventional type cutter-bar the harvester will cut a standing green crop, like grass and lucerne, chop it and load it into a trailer, but the chopping stage can be by-passed if desired and the crop loaded direct. Alternatively, the machine can cut the crop and leave it in windrows, after which it can be lifted by the pick-up reel, chopped and loaded into the trailer.

The harvester can be towed and operated by any medium-sized tractor fitted with a power take-off. From the cutter-bar—or the pick-up reel, if in use—the crop is fed to a conveyor belt, which delivers it on to a cylindrical feeder roll, where it is pressed and fed across a shear plate to the chopping drum. Chopping is effected by the action of four spiral blades against a tool steel shear blade, the latter being adjustable for wear. The chopped material is then delivered by centrifugal force and air blast to a slatted canvas elevator and is finally loaded, through a deflector hood, into a trailer. Other features of this forage harvester which we noted are that a built-in blade sharpener is provided for sharpening the chopping drum knives, and that, for use with tall crops, an adjustable four-bat reel is fitted. Moreover, it is possible to use the harvester as a stationary chopper and elevator for fodder.

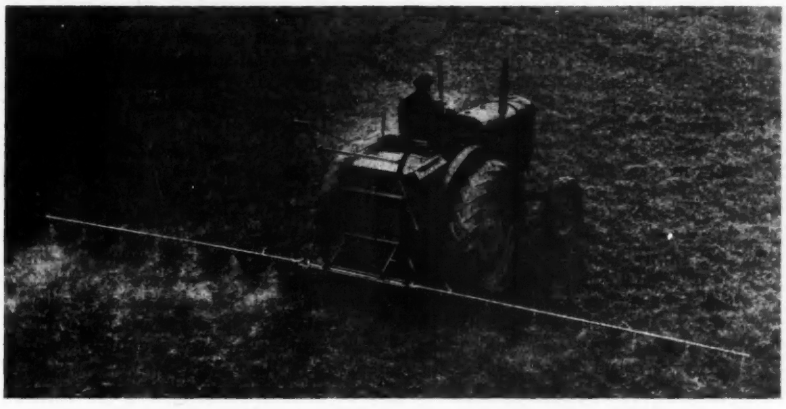


FIG. 18—"SUPERWEEDMASTER" SPRAYER—PEST CONTROL

The Fisher Humphries exhibit also included some strongly-built ploughs, one of which, the "Bracre," has been specially designed for particularly tough ploughing that may be necessary in land reclamation schemes. This plough is constructed almost entirely of steel, and the heel of its knife coulter is pegged on to the leading nose of the share, an arrangement which, it is claimed, gives greater rigidity and strength. The cutting width of the high carbon steel share is 19in, and it is stated to be capable of turning a furrow 14in deep.

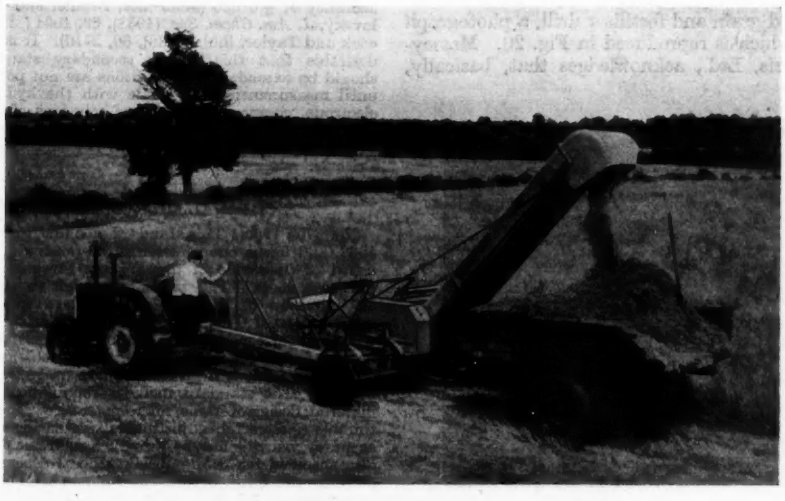


FIG. 17—FORAGE HARVESTER—FISHER HUMPHRIES

PEST CONTROL, LTD.

Despite some difference of opinion in agricultural circles as to its efficacy, crop spraying has become increasingly accepted in recent years as a means of dealing successfully with plant infestation of various kinds. Pest Control, Ltd., Bourn, Cambridge, is one of the firms which has studied the subject very carefully, and a portion of its exhibit at the Royal Show was distinctly scientific. It included samples of insecticides which have been developed for controlling many types of virus known to attack plants, and also certain types of selective weed killer. In addition, the firm displayed its full range of spraying equipment, among which, incidentally, was a camel-mounted sprayer, designed

for use on cotton and other crops in the Middle East.

In the engraving, Fig. 18, there is illustrated the tractor-mounted "Superweed-master," which is a low-volume sprayer of 60 gallon tank capacity, fitted with agitation equipment. The machine can be attached to the rear axle casing of several different makes of tractor, and is driven by the power take-off through a Hardy-Spicer universal coupling. The tank, which is of welded steel construction, has its internal surfaces protectively coated with anti-corrosive material, and is provided with a splash-proof cover, a sludge-trap sump, and two leak-proof glands. A non-corrodible bronze gear-type pump gives a maximum delivery of 8 gallons per minute at a working pressure of 50 lb per square inch, with a shaft speed of 1400 r.p.m., and the agitator consists of a Monel shaft with corrosion-resisting paddles, the speed of the shaft being approximately 275 r.p.m. The spraybars are in three sections, extending altogether to a width of 25ft, the two outer bars being retractable from the driver's seat so that they can be locked in a vertical position when the equipment is not in use. There are seventeen "Teejet" eyelet-type nozzles at 18in pitch. Individual shut-off valves control the side spraybars and, with the main shut-off valve, are operated from the tractor seat. Good filtration is provided at all the vital points of the unit, and working trials have shown that from 5 to 40 gallons of liquid per acre can be sprayed at 50 lb per square inch pressure with a tractor speed of 4 m.p.h.

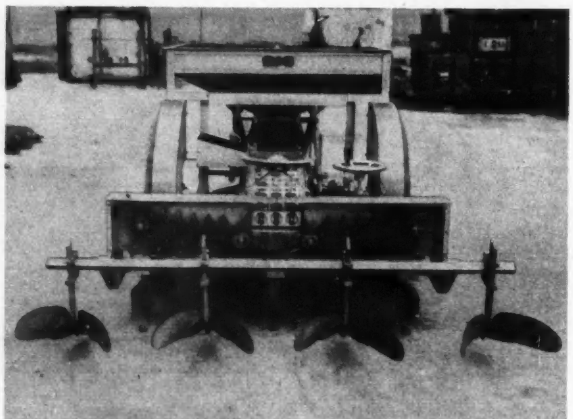


FIG. 19—POTATO PLANTER—TRACTOR SHAFTS

TRACTOR SHAFTS COMPANY, LTD.

One of the potato planters entered for the Royal Agricultural Society's new implement competition was the Smallford three-row automatic machine, illustrated by Fig. 19. It has been produced by the Tractor Shafts Company, Ltd., Smallford, St. Albans, Herts, and one of the practical features emphasised by the designers is the ease of adjustment for "setting" and spacing between rows. The machine is arranged for planting at 12in, 15in, 18in and 21in intervals. The hopper, which is well balanced on the axle, can take from 5 to 6 cwts of graded potatoes, and as the machine is drawn forward, these potatoes fall by gravity on to an agitator which marshalls them down a chute leading to an endless conveyor. This conveyor has a series of cups, grouped in threes, which collect the potatoes and carry them to the rear of the machine where they fall into a box compartment stretching the full width of the planter. The potato in each centre cup falls straight down the centre chute into the ground. The potatoes in the right and left hand cups of the conveyor fall to either side of the box compartment and are taken, by the paddles shown in our engraving, to their appropriate chutes by which they are dropped into the row. The shares mounted at the extreme rear of the machine then cover the planted crop. One operator only is required—in addition to the tractor driver—to work the tool bar lever and clutch and also to check that all the conveyor cups are kept full. The driving wheels of the Smallford planter are 3ft 6in in diameter and have a 5in face. The machine can be turned in its own length, each wheel being fitted with a free-wheel hub.

MASSEY-HARRIS, LTD.

At its works at Barton Dock Road, Manchester, and Kilmarnock, Massey-Harris, Ltd., is now producing a variety of agricultural machinery in addition to its combine harvesters and wheel and half-track tractors. One of the firm's newer productions, which was shown at Oxford, is the No. 720A combined grain and fertiliser drill, a photograph of which is reproduced in Fig. 20. Massey-Harris, Ltd., acknowledges that, basically, this drill differs but little from those manufactured over a long period of years, but many improvements have been made, especially so far as materials of construction are concerned. Cast-iron, which was used for many years, in building implements of this kind, has now been largely replaced by light high-grade steel.

The 720A drill is power-lift operated, and is being made in sizes larger than that illustrated. Fifteen and twenty-row models are in production, the former having an overall width of 10ft 5in, and the latter a width of 13ft 2in. The double forced grain feed runs are driven by a multiple gear disc wheel and thirteen speeds for sowing different quantities may be selected. Each run is divided through the centre, one side being for coarse grain, peas, beans, &c., and the other for fine grain, and for closing off whichever side is not required a hinged reverse plate is fitted. Pressed steel boots conduct the grain into the furrows. For dealing with the fertiliser a star wheel mechanism is provided which, it is claimed, gives accurate and positive sowing. Either of four combinations can be selected by this mechanism, twenty-five quantity settings being available on each.

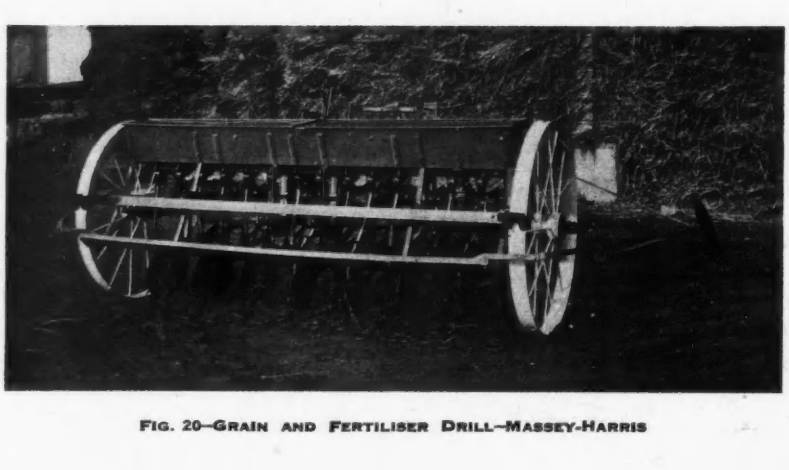


FIG. 20—GRAIN AND FERTILISER DRILL—MASSEY-HARRIS

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1.

pH SCALE

No. 1647 : 1950. This British Standard has been prepared as the result of a suggestion by the Royal Society that a standard pH scale was eminently desirable and that it should be such as to meet international agreement including, if possible, agreement with the scale already proposed in the United States. Originally, pH was intended to denote $-\log_{10}C_H$, where C_H is the hydrogen ion concentration. It is now realised that, if thus defined, pH is not measurable, and accordingly an operational and, to some extent, arbitrary definition has been adopted, (see the comprehensive review by Bates in *Chem. Rev.*, 1948, 42, 1). The object of the standard is to ensure that, when different workers refer to a stated measured value of pH, they mean the same thing within $\pm 0{\cdot}005$. The standard makes it quite clear that this degree of accuracy is only attainable within aqueous solutions at temperatures between 0 deg. Cent. and 60 deg. Cent., and that oxidising agents or other highly reactive materials tend to reduce this accuracy. The method of measurement is given, the primary standard being a one-twentieth molar solution of pure potassium hydrogen phthalate, of which the pH is defined as having a value 4·exactly at 15 deg. Cent. A list of six secondary standards is also included for the use and calibration of the glass electrode. The pH values adopted for the primary and secondary standards are those which have recently been determined by workers in the United States, using the same technique as specified in this British Standard, and which are reliably known to an accuracy of $\pm 0{\cdot}005$ (MacInnes, Belcher and Shedlovsky, *J. Am. Chem. Soc.* (1938), 60, 1094; Hitchcock and Taylor, ibid, (1938), 60, 2710). It is very desirable that this list of secondary standards should be extended, but additions are not possible until measurements are made with the hydrogen electrode, comparing the pH of solutions of these additional substances with the pH of the primary standard in accordance with this British Standard. Price 2s.

EXTERNAL MICROMETERS

No. 870 : 1950. This standard was first issued in 1939, and forms one of a series of standards, published or in course of preparation, for engineers' precision tools. The present revision represents an extension of the previous standard to cover micrometers of 0in to $\frac{1}{2}$in, and from 12in to 24in, with their corresponding metric equivalents, and also provides for micrometers with interchangeable anvils and various measuring ranges up to 24in or 600mm. The standard includes requirements for material, design of frame, micrometer screw, spindle, thimble and barrel, adjustments, measuring faces, accuracy, packing and marking. Requirements are also specified for the material, general design and accuracy of setting gauges. Recommended methods of testing micrometers are given in an appendix. Price 2s. 6d.

An 0-6-0 Diesel Locomotive on the Southern Region

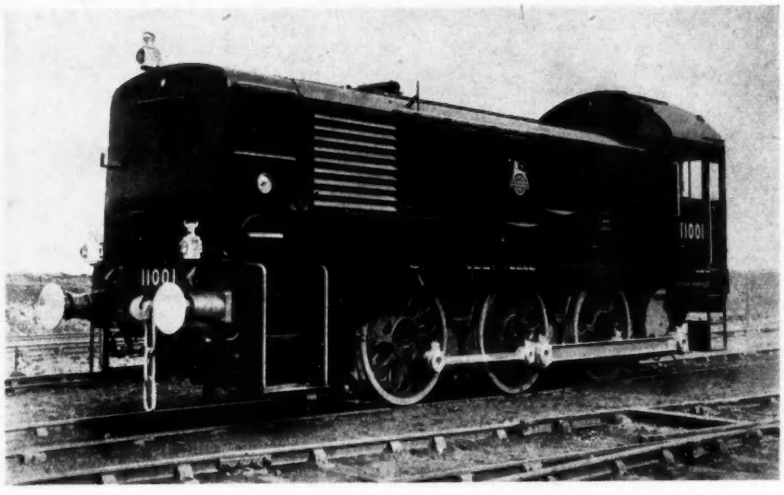
A NEW 0–6–0 diesel locomotive designed for yard shunting and inter-yard working has been put in service in the Norwood area of the Southern Region. This locomotive was built to the designs of Mr. O. V. Bulleid, the former Chief Mechanical Engineer of the Southern Region, and was constructed at the Ashford Works.

In full working order the engine weighs 49 tons 9 cwt, and is 33ft 3in long over its buffers, the wheel base being 12ft 6in. It is designed to negotiate curves of 4 chains and its width of 8ft 7½in will enable it to run over a majority of the Southern Region routes. The locomotive has wheels of the B.F.B. type, 4ft 6in diameter, with S.K.F. split roller bearing axleboxes and underhung spring gear. Horn guides fitted with manganese liners are welded to the frames and welded frame stretchers and dragboxes are fitted. The engine and fluid coupling of the locomotive are carried on a welded bed-plate.

The range of speeds and tractive efforts available are as follows :—

Gear	Low range		High range	
	Speed, m.p.h.	Tractive effort, lb	Speed, m.p.h.	Tractive effort, lb
1	5	33,500	12	13,900
2	9	18,500	21	7,900
3	15	11,500	36	4,600

Developed by the Hydraulic Coupling and Engineering Company, Ltd., the S.S.S. "Powerflow" gearbox was designed and constructed by David Brown and Sons (Huddersfield), Ltd., the gearcase being fabricated and machined by the works at Ashford. This gearbox is fitted with an air-operated reverse and range-selection mechanism. Gear changing is effected by the movement of one lever. First and second gears are engaged by the synchro-self-shifting clutch and the higher speed gear train employed for third gear is engaged by an air-operated traction clutch. This clutch also engages automatically during gear changes, ensuring continuity of torque and virtually eliminating any loss of tractive effort on changing up. The final drive is through reduction gearing to the jackshaft, fitted with balanced cranks, thence to the wheels by connecting rods.



0-6-0 DIESEL LOCOMOTIVE—SOUTHERN REGION

The controls, consisting of a throttle lever, a self-lapping air brake valve, a gear-change lever and a direction lever, are mounted on a desk in the cab and are duplicated for driving from either side of the locomotive. A deadman's treadle is fitted on each side of the desk.

A Westinghouse straight air brake is provided to operate double-shoe clasp brakes through a fully compensated system of brake gear.

A shaft-driven auxiliary gearbox mounted in front of the engine drives a vertically mounted fan for cooling both the water and engine lubricating oil in two Serck radiators mounted on either side of the engine housing; it also drives the compressor, supplying air for the brakes and controls, a water-circulating pump and two dynamos. Two separate electric circuits are used, each with its own bank of accumulators, one for starting and the other for lighting and food heating. An electrically driven lubricating oil priming pump is operated by the starter button and an oil pressure relay switch prevents the starter motor engaging until sufficient oil pressure is built up. At the front end of the locomotive are situated the main fuel tank and the service tank, which have a combined capacity of 600 gallons.

The locomotive, illustrated on this page, is powered by a Paxman 12 RPH, V-12 diesel engine developing 500 b.h.p. at 1250 r.p.m. It has a bore of 7in and a stroke of 7½in, the cylinders being arranged in two banks of six at an included angle of 60 deg. This engine incorporates the Ricardo combustion system with low injection pressures and single-hole, pintle-valve injectors. The fuel pumps are situated between the cylinder banks in two units, one for each bank, and are driven by a camshaft carried in pressure-lubricated bearings in a separate housing and driven by a gear train from the free end of the engine. The underslung crankshaft is journalled in seven main bearings, housed in a simple iron crankcase, the big end bearings and connecting-rods being accessible through the crankcase doors. Drive is taken through a Vulcan Sinclair scoop control fluid coupling and an S.S.S. "Powerflow" gearbox, giving three forward and reverse gears in either high or low range. This arrangement provides a wide operating range from 5 m.p.h. in first gear low range, to 36 m.p.h. in third gear high range.

A cooler fed from the engine cooling system is provided for the fluid coupling, to cater for high slip conditions at low rail speed, and with close adjustment of the engine speed gives a suitable range of speed for hump shunting. On down grades, by moving the gear lever into the "coast" position, the engine is disconnected from the gearbox. This operation withdraws the scoop tube and reduces the engine speed to idling to permit the locomotive to coast.

Institution of Mechanical Engineers: Rules for Examinations

THE existing rules for examinations are those published by the Institution of Mechanical Engineers in March, 1948. They will continue to apply to the examinations of the Institution held up to and including the examinations of October, 1951.

The Council of the Institution has now approved new rules and syllabuses for the conduct of Section B of the Associate Membership Examination. These will be first applied at the examinations to be held in April, 1952. They will be applied, until further notice, to subsequent examinations after that date. The existing requirement that the successful completion of the Associate Membership Examination as a whole (apart from approved exemptions) shall include the passing of each of its Sections A, B and C will remain in operation. The variation of the examination of which notice is now given will only affect the structure of, and requirements within, Section B.

The requirement in the existing rules that three subjects must be taken in Section B will be replaced in the new rules by a requirement that four subjects must be taken in that Section, which will be divided into three groups. From the date mentioned above the four subjects must be taken from the three groups in a prescribed manner.

A summary outline of the whole Associate Membership Examination as it will be conducted under the new rules is set out below. It indicates the relationships of the three Sections A, B and C to one another and further indicates the available alternatives within Sections A and B for the satisfactory completion of the examination.

SECTION A (Six papers)

Four Compulsory Papers (1)–(4)

(1) English.
(2) Mathematics.
(3) Applied mechanics.
(4) Engineering drawing.

Two Further Papers to be Chosen from the Following:

(5) Applied heat.
(6) Principles of electricity.
(7) Physics (which may not be taken with (5) or (6)).
(8) Chemistry.
(9) Workshop technology.

SECTION B

(Four papers from two or three groups)

Group I.—Two compulsory papers.
(10) Theory of machines.
(11) Properties and strength of materials.

Group II.—One or two papers selected from
(12) Applied thermodynamics.
(13) Mechanics of fluids.
(14) Electrotechnology.
(15) Metallurgy.
(16) Theory of structures.

Group III.—One selected paper from the following if only one paper has been selected from Group II. For subjects (17), (18) and (20), the subject (13) must have been taken in Group II. For subjects (21), (22), (24) and (26) the subject (12) must have been taken in Group II.

*(17) Aeronautics I.
*(18) Aeronautics II.
(19) Metrology and machine tools.
(20) Hydraulic engineering.
(21) Internal combustion engineering.
(22) Steam engineering.
(23) Air conditioning, heating and ventilating engineering.
(24) Automobile engineering.
(25) Mechanical engineering in the chemical industry.
(26) Refrigeration engineering.
(27) Fuel and combustion engineering.
†(28) Agricultural engineering.
†(29) Textile engineering.

SECTION C (One paper)

(30) Industrial Administration.

* Syllabuses will be issued shortly.
† Syllabuses under consideration.

The two compulsory papers in the existing Section B, namely, Theory of Machines and Properties and Strength of Materials, will remain as compulsory papers under the new rules and they will constitute the new Group I of that Section. The content of the paper on Materials will be somewhat enlarged within the scope of its title.

Group II of the new Section B will comprise five fundamental technical subjects, four of which have been taken from the existing Section B, but with certain modifications. A new subject, Theory of Structures, has been added. One or two of these subjects may be taken, but if only one is chosen then a fourth subject must be taken from the alternatives provided in Group III.

Applied Thermodynamics (subject (12) of the new Section B) will replace the two existing alternatives, namely, "Heat Engines I—Steam and the Steam Engine," and "Heat Engines II—Internal Combustion Engines." These two subjects will appear as separate specialised papers in Group III of the new Section B with more emphasis on practical and advanced applications of general principles.

Mechanics of Fluids (subject (13)) will replace the existing paper in Hydraulics and will include the flow of gases. The technological applications will be dealt with in specialised papers in Group III of the new Section B.

Electrotechnology (subject 14)), as at present.

Metallurgy (subject (15)), as at present.

Group III of the new Section B will include a range of subjects calling for more advanced knowledge in the application of engineering science to various specialised branches of mechanical engineering. Only one of these specialised papers may be selected as an alternative to a second subject from Group II.

Group III will include :—

Three subjects of a specialised character from the existing Section B and therefore appropriate to Group III of the new Section B, namely :—

(17) Aeronautics I.
(18) Aeronautics II.
(19) Metrology and machine tools.

The subject of aeronautics has been divided into two alternative papers, of which a candidate is only required to take one. Aeronautics I is mainly concerned with aspects of design, which depend on aerodynamical considerations. Aeronautics II is mainly concerned with aspects of design which depend on structural principles.

Three subjects dealing with the application of fundamental principles embodied in the Group II subjects, namely :—

(20) Hydraulic engineering.
(21) Internal combustion engineering.
(22) Steam engineering.

Seven specialised subjects for which there is a clear demand :—

(23) Air conditioning, heating and ventilating engineering.
(24) Automobile engineering.
(25) Mechanical engineering in the chemical industry.
(26) Refrigeration engineering.
(27) Fuel and combustion engineering.
(28) Agricultural engineering.
(29) Textile engineering.

The examination will be so arranged that a candidate can, if he so desires, take all four papers of the new Section B at one sitting, but he will be allowed the alternatives of taking three papers from Groups I and II on one occassion and a fourth subsequently (from Groups II or III) with or without Section C.

For a few years, a pass in three subjects from the first two Groups will continue to be the educational qualification for admission to the class of Graduate, leaving the fourth subject (from either Group II or Group III) as well as Section C to be passed before qualifying for transference to Associate Membership.

MECHANICAL AIDS IN HOUSEBUILDING.—A Ministry of Works booklet, "Machines for the Modern Builder" (H.M.S.O., price 6d.), has recently been issued. Housebuilding, it is pointed out, provides a means of studying the results of mechanisation as applied to building, because many of the operations involved are repetitive.

Ventilation Units at Beevor Iron Foundry

SOME advances in the design of foundry heating and ventilating systems are exemplified by the plant installed in the recently opened Beevor Iron Foundry of Ruston and Hornsby Ltd., Lincoln, for the plant not only includes the first radiant-panel high-pressure hot water heating system to be employed in a foundry, but also a new system of balanced ventilation.

The scheme, designed and installed by Richard Crittall and Co., Ltd., 151, Great Portland Street, London, W.1, provides for the warming of production bays covering a total floor area of 115,000 square feet by means of "Sunzway" radiant panel units, which emit heat to selected parts of the foundry. Ventilation is by means of carefully sited extract and controlled temperature fresh air inlet units.

FIG. 1—COREMAKING DEPARTMENT, FRESH AIR INLET

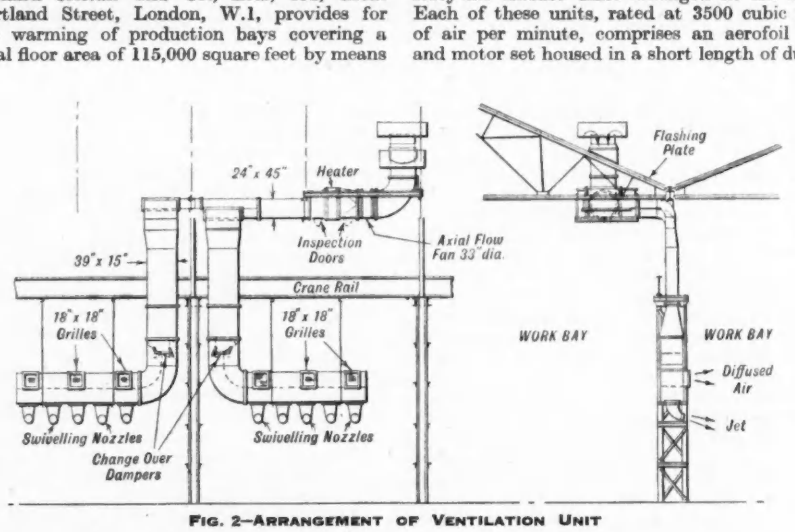


FIG. 2—ARRANGEMENT OF VENTILATION UNIT

The panel units, extract and fresh air units jointly contribute to the high standard of working conditions prevailing in the Beevor foundry. It is of interest to observe that in order to secure good atmospheric conditions at working level all bays are constructed as high as possible, the height to the crane rails being 24ft, to the eaves 32ft, and to the ridge of the roof 43ft. It will thus be seen that heating other than by radiant heat energy would have resulted in heating a large space not occupied by floor workers, with consequent fuel wastage, and considerable difficulty would have been experienced in isolating the supply of heat from "hot-spots."

General ventilation throughout the foundry to ensure that the atmosphere is free from any smoke haze and to give an air change equal to two-and-a-half times the cubic content of the foundry is secured by means of forty-six extract units arranged in the roof. Each of these units, rated at 3500 cubic feet of air per minute, comprises an aerofoil fan and motor set housed in a short length of ductwork, an "Invastyle" and the necessary connecting ductwork.

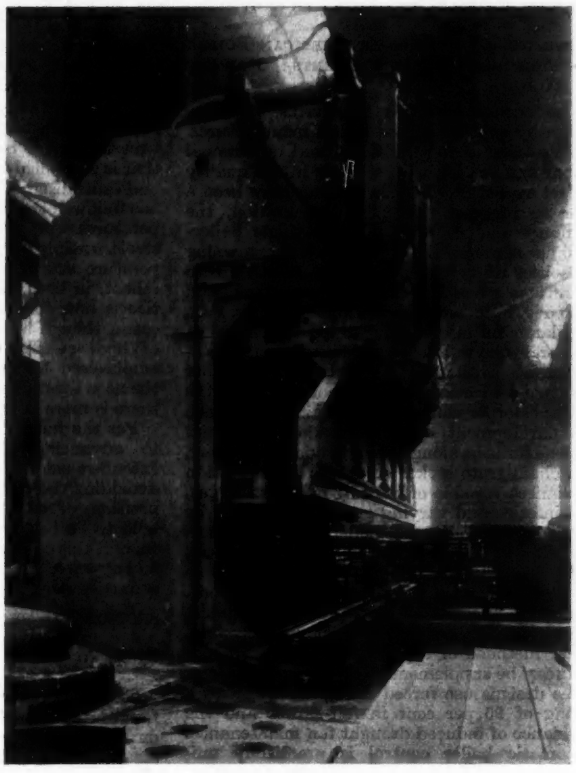
Fresh air to the foundry is supplied by nineteen units, which, delivering a total of 115,500 cubic feet of conditioned air per minute, have been designed and sited with a view to meeting the various demands of the workers and units such as the air suction plant employed for removing foundry sand from the knockouts, &c.

These fresh air units are of two distinct types. One type is designed to deliver air by diffusion only and is manufactured in two sizes, with a capacity of 3500 and 5500 cubic feet of air per minute, respec-

tively. The other, of 9000 cubic feet of air per minute capacity, is arranged with dual delivery ducts so that the air may be diffused through the adjacent working area or, alternatively, the air may be delivered in the form of a jet to a chosen spot by means of swivelling nozzles.

The smaller capacity model of which a typical example, employed for supplying tempered air to female workers in the coremaking department for general ventilation, is shown in Fig. 1. This unit is fitted with an air heater of Spiral Tube and Components, Ltd., manufacture, a Keith Blackman axial flow fan. In order to provide efficient distribution of air without draught to the ventilated space, suitably sized "Deflecto" grilles have been fitted to the air outlets. In addition, the temperature of the delivered air is adjusted according to requirements by the workers through readily accessible automatic controls.

From Fig. 2 in which is shown a drawing of one of the larger units, it will be seen that fresh air is taken in above the foundry roof at a point remote from the extract units. After passing through the axial flow fan and spiral gilled copper tube type heater, the air is delivered in equal proportions to two branch ducts, which are offset for fixing between the workbays and on each side of a stanchion. Diffused air supply from each of these branch ducts is distributed by three grilles, located at 12ft above ground level. The jet supply of air is from nozzles immediately beneath the grilles; the jets being arranged to discharge air towards the floor level and provided with a swivelling base for directional control. Changeover from diffused to jet air supply and vice versa is effected by means of the manually operated damper shown on the vertical section of each distribution duct and the temperature of the delivery air is under the direct control of floor workers, by means of thermostatic equipment manufactured by British Thermostat Company, Ltd.



HYDRAULIC PRESS FOR CYLINDER PLATE BENDING

A Cylinder Bending Press

A LARGE new hydraulically operated bending press has recently been installed at the works of Daniel Adamson and Co, Ltd., Dukinfield, Cheshire, for the manufacture of thick-walled cylinders for boiler drums or pressure vessels required for the oil and other industries. It is designed to roll or press from one plate two-thirds of a cylinder up to 5ft 9in diameter by 32ft long. Plates up to 2¼in thick can be bent cold and plates up to 4in thick can be handled after they have been heated in a specially designed furnace adjoining the press. When it is required to make vessels greater than 5ft 9in diameter the cylinders are rolled by forming three segments each of 120 deg. arc.

The new machine, which is illustrated in the photograph we reproduce herewith, was designed to the particular requirements of Daniel Adamson and Co., Ltd., by Eumuco (England), Ltd. Its fabricated main frame is built up of heavy mild steel plates and is made in three units. Each of the units has a bed 8ft long, and to the 24ft bed so formed an extension piece, 4ft long, is added at each end. By adopting this unit form of construction it will be possible at a later date to increase the length of the machine should it be required to increase its capacity. In manufacturing the open-fronted main frames particular care was taken to incorporate great rigidity in order to reduce deflection to a minimum when working under maximum load.

Each of the three main frame units is provided with a hydraulic cylinder and the rams of the three cylinders are rigidly coupled to a heavy bending beam. The punch or bending die used on the machine is comparatively narrow, being only 4in wide. It has a curved nose and is made in four sections, which can easily be removed should alternative tools have to be fitted. For bending purposes the machine is fitted with an adjustable "step" die operated through gearing by an electric motor.

The press feeding device is operated by a hydraulic ram controlled by limit switches which are set to a predetermined feed setting according to the radius of bend required on the finished cylinder. The manipulating table in front of the press consists of skid bars carried on pneumatic cushions, which give a degree of flexibility to the table under all operating conditions.

The downward stroke of the press is accurately controlled by means of a limit switch to prevent overbending of the plates to too sharp a radius. This limit switch is attached to the main ram and can be adjusted to compensate for varying thicknesses of plate; it operates a solenoid which in turn actuates a pilot valve and through this valve a hydraulic control valve.

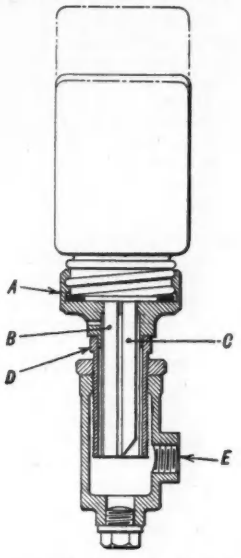
In the sequence of operations followed in bending, the plate is laid upon skid rails on the manipulating table and side guide beams are moved up to the edge to ensure that the plate will be fed square to the axis of the press punch. The ram-operated feed head then moves the plate forward into the press a predetermined distance, when its limit switch cuts out travel. When the feed ram is withdrawn the first movement of a control lever admits low-pressure water to the main cylinders to bring the punch into contact with the plate. Further movement of the control lever admits high-pressure water to the main cylinders to apply the full bending pressure on the plate. When the predetermined bending stroke has been completed the main limit switch comes into effect to stop ram movement and the rams are then withdrawn to raise the punch a few inches clear of the plate. The plate is then pushed forwards by the feed ram and the bending cycle is repeated.

It will be appreciated that by the incorporation of limit switching mechanisms and sensitive hydraulic control gear the operation of the press has been made almost fully automatic, and cylinders complying with very close tolerances can be produced. Special equipment has been fitted for handling plates over 2½in thick between the adjacent heating furnace and the press.

A Constant-Level Oiler

A CONSTANT-LEVEL oiler, made by Denco Engineering Services, Ltd., 3, Eign Street, Hereford, has been designed for a wide range of industrial uses. This little unit, which is made with 4-oz or 8-oz capacity reservoirs, can be used to maintain automatically a supply of lubricating oil to ring, ball, roller or wick-feed bearings, gearbox sumps, &c.

The simple design and construction of the oiler and its principle of operation can be seen from the drawing we reproduce below. A transparent oil reservoir is screwed into an adapter *A*,



ARRANGEMENT OF OILER

from which two tubes *B* and *C* extend down through an adjusting sleeve *D* into the body of the unit. The outlet *E* is connected to the bearing housing or point to be lubricated at the level at which the lubricant is required to be maintained. The tube *B* has a square end and the tube *C* is chamfered at an angle.

The oiler works on the principle, that, as the level of the oil in the bearing housing falls, so does the level in the oiler body. When the drop of the common oil level has reached a certain point the chamfered end of the feed tube *C* is exposed allowing air to be admited into the oil reservoir. This admission of air releases an equivalent amount of oil down the tube *B* and when the preset oil level is reached in the body the chamfered end of the air feed tube is sealed. This cycle is repeated whenever the level of oil falls and continues until the reservoir is empty.

"THE USE OF STRUCTURAL STEEL IN BUILDING."—A brochure with the above title has recently been prepared by the British Constructional Steelwork Association, Artillery House, Artillery Row, London, S.W.1, from whom copies may be obtained free of charge on application.

Fourth World Power Conference

No. II—(*Continued from page 47, July 14th*)

We continue below our abstracts from the "general report" papers of the Fourth World Power Conference, which was held last week in London.

SECTION E2.—PRODUCTION OF STEAM POWER —STEAM GENERATION

By ARTHUR HOWELL, M.I.E.E., M.I.Mech.E., F.InstF., M.Inst.M.§

PAPER NO. 1: DEVELOPMENTS IN WATER-TUBE BOILER DESIGN: SIMONSON (G.B.)

This paper discusses British water-tube boiler design, and emphasises the post-war plant shortage and the inferiority and higher cost of fuels, together with the need for higher availability.

The present trend is towards larger boilers suitable for use with turbo-alternators, and towards higher operating steam conditions, the highest pressure and temperature being, at present, 1600 lb per square inch, and 1070 deg. Fah.

Besides the orthodox stoker-firing used where steam demand is below 250,000 lb per hour, and pulverised fuel firing above this capacity, the spreader stoker with improvements in grit re-firing has advantages in reducing deposit formation; and units up to 240,000 lb per hour are going into commission at present.

Steam temperature is commonly controlled by interstage surface attemperators, other methods using gas dampers, tilting burners, or control of burners in tiered formation.

Fully automatic control, though not widely used hitherto, tends to be more generally adopted with the more exacting steam conditions and load regulation requirements, and with the need for maintaining high efficiency; it is regarded as a logical development of power-operated centralised controls. Some installations use unified control in which auxiliaries driven by direct current are controlled from a single motor generator or rectifier. Automatic sequence-controlled soot-blowers are favoured. For pressure parts, welding is widely used under careful control and with radiographic examination. The use of longitudinally welded boiler tubes is envisaged.

For the future, the limitations of the present heat cycles are leading to more consideration of reheat which, especially in unit designs, offers increased economy without undue complication. Consideration is also being given to combined steam and gas cycles, of which one is described.

PAPER NO. 2: DESIGN OF MODERN STEAM-GENERATING UNITS FOR HIGH-PRESSURE, HIGH-TEMPERATURE SERVICE: ARMACOST (U.S.)

The paper discusses boilers operating at or above 900 lb per square inch, 900 deg. Fah., as made by one United States manufacturer. Capital saving has influenced the trend towards the large boilers of standardised design. Boiler furnaces are now more liberally designed, and will burn a wider range of fuels. Annual availability is about 90 per cent, including routine outage.

Tilting burners are being successfully used for superheat temperature control, other methods using desuperheaters or by-pass dampers. With the development of the high radiant type furnace, burners in tiers facilitate the temperature control. Various grades of alloy steel are needed for the superheater tubes, to withstand the higher temperatures, as many as six different grades being used in one installation; most are ferritic, austenitic alloys being used sparingly where necessary. Pulveriser design is exemplified by the bowl type mill.

The use of radiant superheaters, though not at present extensive in America, is expected to increase where greater superheat absorption is needed, though radiant superheaters and reheaters will, in the authors' view, be avoided in reheat installations at present pressures. Operation at low loads has been possible, down to 5 per cent of full load, with a three pulveriser unit. Methods of air heater washing include dry air, superheated steam, and alkaline solutions. Indications are that, following a probationary period with 100 deg. to 1100 deg. Fah., boilers will be designed for 1200 deg. Fah. at pressures of 2000 lb per square inch or over.

§ Merz and McLellan, Consulting Engineers.

PAPER NO. 3: TRENDS IN AMERICAN BOILER PERFORMANCE REQUIREMENTS: ROWAND (U.S.)

The author describes the status of boiler design by another United States manufacturer. Rising costs of constructional and operational labour and of fuel, with changes in the quality of fuel available for steam raising, have been a spur to progress. In power generation, the economy and simplicity of the single boiler-turbine combination has involved steaming capacities up to 1,370,000 lb per hour. Steam conditions reach 2300 lb per square inch, and 1050 deg. Fah., with reheat up to 1000 deg. Fah. The large furnace sizes have led to the use of a central tube wall in order to increase the heating surface available in a given volume. Boiler efficiencies of nearly 90 per cent based on the higher calorific value can be attained, and with the development of the spreader-stoker and cyclone furnace, along with pulverised fuel firing, and chain-grate stoker equipment, combustion appliances capable of burning oil, natural gas, and inferior and varying grades of coal can be applied to an individual boiler. This is important in the United States where solid, liquid, and gaseous fuels of various grades are available in various combinations in different regions. Pulverised fuel boilers have developed almost without exception on the unit mill system. Other methods of superheat temperature control may be supplemented by gas recirculation. Some designs use forced draught only, with a saving of 25 per cent in fan power and the avoidance of induced draught fan maintenance. Automatic boiler control is practically universal as an aid to continuously good operation, and centralised operation minimises operating labour.

Greater attention is perforce being given to reducing the discharge of fly-ash from chimneys; a limit of 0·85 lb of dust (over 1 micron) per 1000 lb of gas adjusted to 50 per cent excess air is being seriously considered.

The cyclone furnace is capable of burning effectively a wide range of low-grade coals with a minimum of fly-ash discharge, since 85 per cent of the ash is said to be collected as molten slag. Practically zero carbon loss is obtained with as little as 10 per cent excess air. A typical design burns crushed coal or natural gas and evaporates 830,000 lb per hour of steam at 1850 lb per square inch and 1010 deg. Fah., with reheat to the same temperature; with an anticipated exit dust burden of less than 1·2 lb per 1000 lb of gas, grit extractors are sometimes dispensed with. The efficiency is expected to reach 88·5 per cent with low-grade coals and 20 per cent excess air. Units such as these have been developed to deal with Mid-West coals where the ash softening temperature ranges from 1950 deg. to 2300 deg. Fah.

Spreader stokers are frequenty used up to 200,000 lb per hour due to their flexibility as regards variability of fuel, with the boiler set high to minimise partly burnt fuel and with grit re-firing.

Acid cleaning is being employed for the internal surfaces of the pressure parts.

GENERAL TRENDS

One of the most outstanding characteristics of the phase of development outlined in the papers, is the extent to which power generation has come to the aid of fuel economy in many lands by burning, with surprisingly high efficiency, fuels that would be of little use for other purposes; this has not been achieved without more liberally designed and therefore larger and more expensive boilers, as well as more expensive dust extraction. Notwithstanding the inferior fuels, high availability has been maintained by more suitable design supplemented by better methods of on-load cleaning, so that it has been possible to reduce capital charges and to simplify design and operation by using large boiler-turbine units; and this in turn has directed attention to low-load performance. For similar reasons, attempts are being made, if rather tentatively, to standardise boilers at least partially, and in the smaller sizes. Another feature has been the development of the cyclone furnace, where the ash fusion temperature is suitable, and of the spreader stoker for lower capacities. On the other hand, it is noticeable that among the countries represented at the Conference the natural-circulation boiler has so far usually held the field, even at the highest pressures, against what were at one time thought to be serious competitors. Operation is simplified by a greater use of automatic and centralised control. Better cycle efficiency has followed the use of the more advanced temperatures and pressures permitted by newer steels, mainly ferritic, with greater high-temperature strength, and by the greater use of reheat, in both of which respects marine practice is now following land practice in suitable cases, though at a discreet distance. The use of high steam temperature has incidentally emphasised the need for its closer control. On the need for radiant superheaters and reheaters, there is more than one view.

For the future, some look for high efficiency to advancing steam temperature and the extended use of reheat, while others advocate extending the temperature range by the superposition of a gas turbine cycle, which they hold to be better able to use the temperature, though this seems to involve, in the near future at any rate, the use of oil fuel, which not all countries may find convenient.

SECTION E3.—PRODUCTION OF STEAM POWER —TURBINES AND AUXILIARIES

By I. VINCENT ROBINSON, Wh.Sch., M.I.C.E., M.I. Mech E., Mem.Am.Soc.M.E.‖

The papers in this section are nine in number; four of them are contributions by manufacturers on the present trends in the design of large steam turbines. These are by Parker, General Electric Co., U.S.A.; Campbell, Westinghouse Electric Corporation, U.S.A.; Dollin, C. A. Parsons and Co., United Kingdom; and Seippel, Brown Boveri and Co., Switzerland. In addition, there is also a report on the present position of the mercury turbine, by Hackett, General Electric Co., U.S.A., and another report on operating experience with high-pressure high-temperature turbines by Thompson, of the Detroit Edison Co., U.S.A.

There are also three papers dealing respectively with the operation of cooling towers, by Mulder, Holland; condensing of steam by means of air, by Heller, Hungary; and the driving of turbine auxiliaries, by Flatt, Switzerland.

The first four papers naturally have a good deal in common, Parker and Campbell basing their papers upon actual experience of their respective firms over recent years. Dollin states that in the United Kingdom 30MW and 60MW units have been standardised by the British Electricity Authority, and that there is some prospect of 100MW units being standardised in the very near future. As regards capacity Parker states that the maximum size with single casing machines is 37·5MW, and with a tandem-compound treble-flow machine the maximum size at present is 153MW at 3600 r.p.m. Campbell refers to a unit of 125MW at 3600 r.p.m. Both state that no progress has been made with the 1800 r.p.m. machines, as the higher-speed unit could be supplied in as large a unit as the load demanded. The smaller dimensions of the high-speed unit are more suitable for high temperatures. Dollin also refers to the type of machine that will be used for outputs of 100MW at 3000 r.p.m.

Seippel, of Switzerland, describes a unit of 110MW at 3000 r.p.m., intended for a French power station. This is of the three-cylinder quadruple-flow type, whereas the Americans

‖ Turbine Division, British Electrical and Allied Manufacturers' Association.

instead of using four exhausts, would confine themselves to three exhausts up to about 150MW, 3600 r.p.m., and two exhausts for 100MW. Seippel explains why, in their opinion, the four-exhaust machine is less expensive than a double-exhaust machine.

The four papers by Dollin, Parker, Campbell and Seippel all deal with the modern trend towards higher steam pressures and temperatures. The Americans have plants running with steam at pressures of 1800 lb and 2000 lb per square inch, and a large number of plants designed, and some working, for steam at a temperature of 1050 deg. Fah. Dollin also states that 1500 lb per square inch and 1050 deg. Fah. have been adopted in the United Kingdom for some 60MW sets now being constructed, and will be adopted for the 100MW unit now under consideration. Campbell states that, of the orders received by his firm in 1948, over 91 per cent on a capacity basis was for steam at 900 deg. Fah. or over; over 60 per cent at 950 deg. Fah.; and 19 per cent at 1000 deg. to 1050 deg. Fah. It is suggested that the next advance will be towards a temperature of 1100 deg. Fah. associated with a pressure of probably 2200 lb per square inch, and if, and when, 1200 deg. Fah. steam can be used, the pressure will probably be the critical—3200 lb per square inch. Reference is made by several authors to a double-casing turbine for 1500 lb per square inch and 1050 deg. Fah. Dollin suggests that such a design is undesirable as it makes access much more difficult for maintenance purposes, and Thompson and Parker both suggest a double casing with proper design is not needed for pressures up to 1250 lb per square inch and 1050 deg. Fah.

All authors call attention to the fact that the area of the last row of blades determines the maximum output of the unit. Both Parker and Campbell refer to the limiting blade used in America, which is 23in high at 3600 r.p.m. This blade is mounted on a drum or disc with a pitch diameter of 65·5in, giving at 3600 r.p.m. a tip speed of 1395ft per second.

All three authors differentiate the blading in the two types of turbine by the degree of reaction—from zero to 50 per cent—and also make reference to the use of vortex blading. Dollin is doubtful whether the improvement in efficiency resulting from the use of this system of blading is adequate recompense for the increased cost of manufacture.

The authors all refer to the use of twisted blading, but practice differs on the distance of such blades from the last row.

Seippel discusses vortex blading, and suggests how rotational motion in the steam is caused with ordinarily untwisted blades. The eddies are diffused in the flow stream and energy is lost, being converted into heat. If rotation persists at the last row of blades, the losses are greater than after earlier stages. He states that there is no accepted law in determining the degree of twist to be given to blades at various radii in order to eliminate as far as possible the rotational motion.

Dollin refers to the effect of wetness in the steam, and suggests that the various methods adopted for withdrawing it may extract perhaps 25 per cent of the total quantity of moisture, which, in his opinion, is insufficient. He refers to the erosive effect of the moisture upon the last row of blades and the use of Stellite shields. Seippel also mentions means of removing the water from the steam, and suggests that perhaps 50 per cent may be withdrawn by the system of ducts and orifices which he describes. He then states that he has had instances where, under identical conditions, there has been blade erosion with older machines which has been avoided entirely with newer machines with this system of ducts and orifices.

All authors refer to the use of a reheat cycle, and are apparently agreed that full reheat on reasonable assumptions regarding pressure drop, &c., is equivalent in results to that which could be obtained by an additional 130 deg. to 150 deg. Fah. in the initial steam temperature.

All papers refer to the necessity of avoiding, as far as good design can provide, differential expansions due to high temperature. Dollin points to the type of rotor used in a high-pressure cylinder in which there is no joint at the inlet end. At the low end, a stub shaft is welded into the hollow drum end of the rotor. It is claimed that this equalises the heat absorption capacity of the rotor and the cylinder, thus tending to equalise the rate of expansion. Parker refers to the necessity of symmetrical disposition of pipes, valves, branches, &c., about both the horizontal and vertical diameter in transverse section. Parker mentions the admission of throttle steam in both the upper and lower halves of the turbine cylinder, which improves symmetry. Alternatively, a separate steam chest, or chests, could be used with flexible and symmetrical connection to the cylinder. Such symmetrical disposition results in dimensional stability.

All authors make numerous references to the materials used for various parts of the turbine for the high pressures and temperatures. Dollin suggests that plain carbon steel can be used to 800 deg. Fah.; Campbell up to 825 deg. Fah.; Parker does not specify any figure but considers that it may be used for "low temperatures." At 925 deg. Fah. Dollin suggests a carbon-molybdenum alloy; Parker suggests an alloy containing molybdenum for temperatures above the carbon steel limit and one containing molybdenum and vanadium up to 1000 deg. Fah. Campbell suggests that an alloy containing increasing amounts of chromium can be used for temperatures up to 1050 deg. Fah. He suggests 0·5 per cent chromium to 900 deg. Fah., 1 per cent to 950 deg. Fah., both with 0·5 per cent molybdenum, but 2·25 per cent chromium and 1 per cent molybdenum to 1050 deg. Fah. He also suggests using an austenitic material for rotors, for temperatures over 1000 deg. Fah. This would be a nickel-chromium-molybdenum alloy. For the highest temperature, 1050 deg. Fah., Dollin recommends molybdenum-vanadium alloy, and Parker molybdenum-vanadium-chromium.

For blading, Campbell suggests an alloy carbon steel containing 13 per cent chromium, i.e., stainless steel. For bolting up to 850 deg. Fah., Campbell proposes chromium-molybdenum alloy, and for 950 deg. Fah. the same with the addition of vanadium. For bolting at 1050 deg. Fah., Campbell suggests an austenitic steel stabilised with columbium and containing also some tungsten. For blading, Dollin also suggests stainless steel up to 950 deg. Fah., and from there up to 1050 deg. Fah. an austenitic steel stabilised with titanium or columbium. He calls attention to the possible trouble arising from the differential expansion of a ferritic rotor and austenitic blades.

Parker states that for the highest temperatures, rotors should be made from solid forgings of chromium-molybdenum-vanadium alloy. He does not refer to the blading material. For the highest temperatures, Dollin recommends forgings, wherever they can possibly be used, of molybdenum-vanadium steel, and considers austenitic steels unnecessary. Campbell also advocates forgings where possible for parts in contact with temperatures over 1000 deg. Fah. For steam pipes, however, Dollin thinks austenitic steels or molybdenum-vanadium alloy may have to be used.

Dollin refers to the use, on high-pressure high-temperature cylinders, of supervisory instruments designed to indicate unequal expansions of cylinder and rotor, eccentric running of the rotor, and the shaft axial position. With such instruments it is suggested that sufficient information is obtainable regarding the actual condition of the machine and its reliability, particularly when stopping and starting frequently, as will have to be done. On any system, the newest units will naturally be given the long-hour load on the score of economy, but later in life they will no longer be the most economical and may have to stop and start every day. Under these conditions, they must be reliable.

The paper by Thompson represents the experience of a number of public supply companies in the United States, i.e., the companies included in the Edison Association. It mentions various troubles that have been experienced, and the means or materials adopted to overcome them. Generally, it is a confirmation of the statements of the various manufacturers as to the most suitable materials for various parts of the steam turbines under temperatures up to 1050 deg. Fah.

He also refers to the availability of plant, stating that steam turbines have reached a figure of 94 per cent and boilers 90 per cent. These figures exclude the varied load demand during week-ends and holidays.

Seippel approaches the turbine problem from another angle altogether. He points out that the efficiency of any portion of a turbine may be improved by adopting a more expensive design, and suggests that an increase in the value of the turbine resulting from this improvement, measured by a reduction in fuel consumption, is obtainable at a certain cost. The ratio of the value of the improvement to the cost of obtaining it should be the same for all portions of the turbine. He points out that it serves no useful purpose to increase the value of the turbine by redesigning one particular section of the turbine, such as, for example, the exhaust end from the last row of blades to the condenser inlet, at a certain cost when the same increased value could be obtained at a lower cost by improving the performance of some other portion of the turbine. He also points out that the ratio of the value of the improvement to the extra cost by which it has been attained should be the same for all components of a turbine which are capable of such treatment.

The paper by Mulder deals with the theory of natural-draught cooling towers, and is based upon Merkel's 1925 mathematical analysis. The essential point of this analysis is that the driving force conveying the heat of the water to be cooled to the cooling air rising up the tower is the difference in the heat contained in each pound of air in the atmosphere before and after the air has passed through the water.

The paper by Heller outlines a method by which it is claimed that better operation can be obtained in turbo-generating plant with a jet condenser than with the ordinary surface condenser. The cooling water used in this jet condenser is circulated in a closed cycle, and is of the same quality as the condensate. At the base of the condenser some of the mixed condensate and injection or cooling water is withdrawn by an extraction pump and discharged to the boiler via the usual feed pump. The bulk of the water from the bottom of the condenser is then passed on the closed cycle to an external atmospheric cooler. Here, the water is cooled and, completing the circuit, is supplied to the jet condenser under the turbine. No detailed information is given regarding the cooler required for cooling the circulating water. Claims are made that, having regard to the capital cost and running expenses, the proposed arrangement is more economical than the ordinary surface condenser using cooling towers.

The paper by Flatt suggests a method of driving the auxiliaries of high-pressure high-temperature units by means of which overall efficiency at low loads is not materially different from that at full load. The feed pump is driven by a turbine which is supplied with steam extracted from the turbine at a pressure which, at full load on the unit, is sufficient to drive the feed pump. At lower loads the pressure at the extraction point supplying the feed pump turbine drops, and the author demonstrates that the drop in pressure matches very closely the drop in demand on the feed pump. The steam turbine also drives an auxiliary generator which supplies the power required for other motor-driven pumps amongst the auxiliaries, and the drop in speed of the feed pump turbine, and hence of the auxiliary generator, enables the reduced demand on the auxiliary pumps to be met without generating full pressure and throttling the discharges of the various pumps. By a similar line of argument, the author suggests that the induced-draught fans should be driven by a turbine in series with the main unit, taking the full quantity of steam. According to the variation of load, and hence the variation in the flow of steam, the output of the induced-draught fan matches the boiler requirements.

The paper by Hackett is a factual statement of the history of binary or mercury power plant in the United States. It refers to the

initial installation at Hartford in 1929 of a 10,000kW set, replaced in 1949 by a 15,000kW unit. It points out that the latest unit is a 40,000kW set supplied to the Schiller Station for the New Hampshire Company, and also a 7500kW set at the General Electric Works at Pittsfield, in which the steam is piped to an existing station steam header. Hackett states that the operation of mercury turbines has been considerably improved by a process applied to the mercury which causes it to wet the tube in which it is contained. In other words, the meniscus is concave after treatment, instead of convex. He also points out that owing to the very small variation in the total heat or enthalpy at the exhaust of the turbine, with a considerable range in exhaust pressure, it is possible to use practically the same mercury turbine for plants from which steam is required at greatly varying pressures. Standardisation is thus facilitated.

SECTION F.—INTERNAL COMBUSTION ENGINES

By S. J. Davies, D.Sc.(Eng.), Ph.D., M.I.Mech.E., Wh., Ex.¶

Paper No. 1: Modern Trends in Oil Engine Designs: Wans (G.B.)

This survey is limited to four-stroke oil engines covering powers from 5 b.h.p. to 300 b.h.p. per cylinder and speeds from 1500 r.p.m. to 450 r.p.m.; automotive and large marine and industrial engines are excluded.

In present practice with the higher-speed engines, the normal brake mean effective pressure (b.m.e.p.), unsupercharged, is 80 lb to 90 lb per square inch, and the specific fuel consumption is 0·37 lb to 0·39 lb per brake horsepower hour. Both direct injection and divided combustion chambers are used. Light-alloy air-cooled pistons with fully floating gudgeon pins are usual. Cast iron crankshafts are having some success and the same metal is being used for camshafts, valve levers, gear wheels, &c. Such engines should run 3000 hours without major overhauls.

With engines of medium speeds, the b.m.e.p. ranges from 80 lb, unsupercharged, to 120 lb per square inch when exhaust-turbo pressure-charged. Fuel consumption is about 0·375 lb per brake horsepower hour, and the combustion chambers are almost all of the direct-injection type. Crankshafts are almost exclusively steel forgings. Special emphasis is given to the desirability of long periods between overhauls.

Considering modern trends, specific outputs, already improved by 50 per cent and over by pressure charging, are being further increased; systems embodying both mechanically and exhaust-driven blowers are employed. In the latter, higher outputs are obtained by cooling the air before entry to the cylinders, a difficult process in hot countries. Supercharging pressures are increasing from 5 lb to 8 lb per square inch. With suitable limits to maximum cylinder pressures, a b.m.e.p. of 170 lb per square inch is thought possible. Increasing rotational and piston speeds are also observed. Dampers to offset the effects of torsional vibrations are coming into use. Noise from combustion shock is being reduced by longer injection periods and by pilot injection. Better lubrication has contributed to improved durability, and, in Britain, detergent oils are widely used.

(To be continued)

¶ Professor of Mechanical Engineering, King's College, University of London.

Continental Engineering News

Reconstruction of the Piacenza Bridge, Italy

In August, 1946, the Italian Ministry of Public Works opened a public competition for the construction of a new highway bridge, to replace the Piacenza Bridge over the River Po, a steel truss structure nearly 2000ft long, which was destroyed by aerial bombardment in 1944. The design of the Società Nazionale di Savigliano was adopted by the Ministry and this company started work at the end of 1946. However, it was not possible to obtain rolled steel sections from the mills before August, 1948, and the work was thus considerably delayed.

The new bridge is a steel structure, composed of Gerber trusses. It is 1984ft long and has eight spans each 248ft long. It is cambered towards the centre, in order to improve its appearance and is decked with reinforced concrete slabs with longitudinal and transverse ribs, which divide the decking into 48ft panels. The piers were built using compressed air caissons and were constructed 2ft higher than the piers of the previous bridge, as a result of experience with the floods in 1926. About 1700 tons of steel were required for the new structure, which was given an increased carriageway width of 29½ft. High tensile steel was used for the superstructure, which was erected in six months.

Piacenza Bridge over the River Po

Schiphol Airport, Holland

The facilities of the Schiphol Airport, near Amsterdam, were considerably improved in 1949 by the completion of various new works, including the new North-South runway. This runway, like the existing S.E.-N.W. runway, has a length of 5904ft and a width of 197ft, with a 33ft emergency strip on either side and is suitable for the heaviest aircraft. The lengthening of the E.W. runway (previously 5674ft long) by 754ft in a westerly direction, to link up with the northern end of the N.S. runway, was also completed. A number of approaches were built, including a long road leading to the Fokker Works now under construction. The available hangar space was increased by the completion of No. 8 Hangar, known as the Van der Hoop, built by the City Corporation of Amsterdam, and a further large hangar (No. 9) is now under construction. When completed, it will be 540ft long and 131ft wide, with a clear height of 39ft.

A Ten-Year Plan for the Belgian Congo

The Belgian Government adopted recently a ten-year plan for the economic development of the Belgian Congo. According to this scheme it is intended to invest in the colony a sum amounting to 25,000 million Belgian francs (£178 million). In connection with the work the extraordinary budget contained, in 1949, a provision of 3000 million Belgian francs (about £21 million). The corresponding figure of the 1950 budget is for a similar sum. It is planned to pay special attention to the development of the river network as well as to the modernisation of the harbours. The scheme also contains provision for the construction of new highways and airports. Works will start soon on the construction of a highway between Stanleyville and Kivu and later a railway line will be built between these towns.

In 1950 a sum of 400 million Belgian francs will be spent for the highways and 1000 million for the waterways. It is intended to set up companies for the production and distribution of electric power, with capital contributed by the Government and private owners.

The San Giacomo Dam, Italy

The San Giacomo Dam, recently built by the Electric Administration of the City of Milan, is the largest dam in Italy. It is situated at an altitude of 6560ft on the upper reaches of the Adda River, and has a reservoir capacity of about 65 million cubic yards. The main object of the San Giacomo scheme is to supply the city of Milan with base load electrical energy, to meet the increasing power requirements of the city and its industrial area. The scheme includes a main dam 1640ft long, and two smaller secondary dams for closing off lateral valleys. The concreting programme for the main dam for the 120-day working season was planned for a daily concrete production of 3900 cubic yards.

Regulation of the Elbe River

With the exception of the Rhine, the Elbe is the most important navigable waterway in Germany. It crosses important industrial and commercial regions and has a length in the German territory of 380 miles. In some parts of the river the navigable draught is very small, the minimum being about 2ft. As early as 1929 a scheme was formulated to improve the waterway. The construction of two large weirs was envisaged, one at Bleiloch, which was started in 1934, and one at Hohenwarte, which was started in 1940. The work was stopped in 1943, when about three-fifths of the main scheme had been completed. It is intended to resume the works in the near future, and two dams will be erected on the Upper Elbe (downstream of Pirna), and on the Beraum. After the completion of the scheme, the minimum draught will be increased to 3¼ft, thus enabling 700-ton barges to use the waterway for 302 days in an average year, instead of the present period of 204 days, upstream of the Saale junction, and 327 days (instead of 205 days) downstream of this point.

Cement and Concrete Association's Publications.—Two booklets about concrete construction have recently been issued by the Cement and Concrete Association, 52 Grosvenor Gardens, London, S.W.1. One of these is "Questions and Answers on Concrete Road Construction," which is a review of existing knowledge about concrete road building presented as a series of questions and answers, and the other is the second edition of "Concrete Shell and Barrel Roofs," which is a well-illustrated publication, showing a number of examples of the use of shell and barrel roof construction.

Industrial and Labour Notes

Engineering Wages

The executive council of the Confederation of Shipbuilding and Engineering Unions met in York on Thursday of last week. It was announced that the affiliated unions had voted by 326,233 to 111,049 in favour of arbitration rather than strike action over the rejected claim for a general wage increase of £1 a week. It is understood that thirty-one of the thirty-seven affiliated unions took part in the ballot on this matter, and that about 40 per cent of the union membership represented on the Confederation cast their votes.

The executive council, it is reported, unanimously decided to inform the Minister of Labour of the result of the ballot, and to ask that appropriate action be taken under the Conditions of Employment and National Arbitration Order. That decision was reached after two amendments to the main resolution had been dealt with. The first of them, which was put forward by the National Union of General and Municipal Workers, recommended dropping the claim for £1 a week increase and asking for a £5 a week minimum wage, with suitable adjustments for higher paid workers. The other amendment, moved by the Electrical Trades Union, urged that a new approach be made to the employers immediately on the claim for £1 a week increase.

Now that the dispute has been officially referred to the Minister of Labour, several courses of action are open to him. He may, for example, decide to refer the matter to the National Arbitration Tribunal, he may decide to set up a Court of Inquiry, or he may try to bring the employers and the unions together for further negotiations. Meanwhile, discussions on the new wages structure for the engineering industry are at a standstill.

Railway Wages

In these notes in our last issue, we recorded the offer made by the Railway Executive to increase the wages of lowest paid railway workers by 3s. 6d. a week, with an adjustment for clerical staff at a corresponding level. The National Union of Railwaymen accepted the offer on the understanding that it was "without prejudice to any further claim for all grades."

During the past week, there have been more developments in the matter of railwaymen's wages. The Railway Clerks' Association decided not to accept the Railway Executive's offer, but to put forward a claim for an all-round increase for salaried staffs of 7½ per cent on all existing salaries. The Associated Society of Locomotive Engineers and Firemen also found the Executive's offer unacceptable, and announced on Tuesday last that it had presented a claim for a wage increase of not less than 15 per cent for all its members. In making its announcement the Associated Society said that it was not "in a position to entertain any offer which would have the effect of worsening in any degree the present totally unsatisfactory position with regard to relativity in wage rates."

Finally, before it concluded its annual conference at Morecambe last Saturday, the National Union of Railwaymen instructed its executive to submit a claim for a substantial increase in wages for all its members, at an appropriate date. No indication, however, of the amount of such claim appears to have been given.

Employment and Unemployment

According to figures published at the end of last week by the Ministry of Labour, the working population of Great Britain declined by 27,000—all men—during May, and at the end of that month totalled 23,324,000 (16,058,000 men and 7,266,000 women). The number of men and women in the Forces at the end of May was 688,000.

The number in civil employment increased by 21,000 during May, bringing the total to 22,331,000. In the basic industries, there was a net gain of 5000, but additions to the manpower of the transport and communication and agricultural industries was offset by a further decline in the coal-mining labour force. By the end of May, the number of wage earners on colliery books had dropped to 700,000, which indicates a net loss of 9000 since the beginning of the year. In the manufacturing industries of this country, 8,424,000 people were employed at the end of May. There was a further increase of 2000 in the manpower of the metals, engineering and vehicles group, which brought the total to 3,937,000, compared with 3,922,000 at the beginning of the year. In "other industries and services," building and contracting manpower declined by 1000 during May to 1,487,000, but in the "professional, financial and miscellaneous services" classification, the number employed rose by 10,000 to 3,918,000.

The latest figures for unemployment show that on June 12th, there were 281,996 people registered as out of work, compared with 314,674 on May 15th. The June 12th figure included 39,630 married women, many of whom, of course, may be leaving industry. It also included 190,223 men, of whom 6104 were reported as "temporarily stopped."

Dollar Exports

A statement issued this week by the Board of Trade shows that the value of United Kingdom exports in June to the United States and Canada was below the total achieved in May. Provisionally, the value of June exports to the U.S.A. has been put at £8,000,000, or 22,400,000 dollars and to Canada at £9,300,000, or 26,000,000 dollars. The figures for May were 23,000,000 dollars and 34,700,000 dollars respectively.

Taken together, the value of exports to the U.S.A. and Canada in the second quarter of this year averaged 48,900,000 dollars a month. In the first quarter of this year the monthly average was 42,800,000 dollars, and in the last quarter of 1949 it was 38,700,000 dollars. In the second quarter of last year the monthly rate of United Kingdom exports to North America was at a value of 39,900,000 dollars.

The Finance Corporation for Industry

The fifth annual meeting of the Finance Corporation for Industry, Ltd., was held in London on Thursday of last week, under the chairmanship of Viscount Bruce of Melbourne. It was stated that in the last twelve months, the Corporation's commitments had increased from £61,048,586 to £66,862,641, and since the date of the balance sheet those commitments had risen by a further £6,000,000.

In his chairman's address, Viscount Bruce spoke about the matter of rising costs and about the policy pursued by the boards of the nationalised industries. He also urged that the idea of nationalising the iron and steel industry should be abandoned. In his view, Viscount Bruce said, the iron and steel industry was organised on an ideal basis to give effect to the modern trend of thought as to the necessity for co-operation between the Government and industry. The British Iron and Steel Federation was an organisation of the private firms and companies engaged in the business. Those controlling the firms were men of vast experience, possessing an intimate knowledge of the intricacies and techniques of the industry.

Viscount Bruce then went on to refer to the Federation's long-term programme for the expansion of the iron and steel industry. That programme, he commented, was examined with meticulous care by the Iron and Steel Board, and after certain revisions was endorsed. The industry was now going forward with the implementation of the plan, a matter involving great capital expenditure. Into that ideal situation, Viscount Bruce said, the legislation for nationalising the industry was flung. The result had been to create confusion and uncertainty which might well have been calamitous but for the action of the British Iron and Steel Federation and, incidentally, of the Finance Corporation for Industry. Notwithstanding the threat of nationalisation, the Federation decided to go forward with the implementation of the long-term plan and the Finance Corporation had, to date, supplied the finance which could not be obtained through ordinary channels. Now, Viscount Bruce added, there were grave doubts as to whether the Government could put its legislation into operation. He trusted that the Government would realise the danger that the present state of uncertainty was causing and would have the courage to abandon this piece of legislation, which the result of the last election showed had not the endorsement of the people.

The Swedish Federation of Trade Unions

During last year, membership of the Swedish Federation of Trade Unions increased by 17,345 to a total of 1,255,907. In commenting on this fact, the *Anglo-Swedish Trade Review* says that the largest unions in Sweden are now the Metal Industry Workers' Union, the Building and Construction Workers' Union, the Municipal Workers' Union, the Railwaymen's Union, and the Commercial Workers' Union.

The annual report of the Federation shows that during 1949 there was a high rate of employment in practically all branches of Swedish industry, unemployment among trade union members averaging only 2·6 per cent, compared with from 9 to 10 per cent before the war. The report also records that no bargained wage increases occurred during the year owing to the general prolongation of existing collective agreements. The post-war period, however, has been marked by an upward swing of the wage curve independently of the results of collective bargaining. This, it is suggested, is accounted for chiefly by higher piecework earnings. The total average increase in hourly earnings for the year is reported to have been 3·5 per cent.

Metal Prices

During the past week, two increases have been made in the price of lead, and, according to a statement by the Ministry of Supply, the price of good soft pig lead, as from July 14th, is £96 per ton delivered. The Ministry has also announced increases, from July 18th, in zinc premiums. The premiums are now as follows:—refined and electrolytic zinc, £4 10s.; not less than 99·99 per cent purity, £10 10s. The prices of zinc metal sold by the Ministry, per long ton delivered buyer's premises are:—G.O.B., Prime Western and de-based, £127 10s. (unchanged); refined and electrolytic, £132; not less than 99·99 per cent purity, £138.

Maximum prices of a limited range of iron and steel products have been amended by the Iron and Steel Prices (No. 2) Order, which came into operation on July 17th. The products are mainly those affected by the recent increase in the price of nickel. The principal alterations specified in the Order are in the prices of alloy steel billets according to quality, but the prices of some other alloy and stainless steel products have also been increased.

French Engineering News

(From our French Correspondent)

Reduction of activity in the steel and metal industries is likely to have serious repercussions on employment in the future, according to the Secretary of the Metal Federation (Christian Trade Unions). Out of the 170 steel factories now in existence, the number is to be reduced to twenty. Already the automobile industry has seen the number of constructors reduced from 200 in 1935 to thirty-seven in 1950, and, practically speaking, the "big five" supply 90 per cent of present production. While modernisation of equipment was necessary to conserve and increase markets open to French production, the Secretary thought insufficient attention had been paid to conditions of re-employment of personnel.

* * *

The report of the Administrative Council presented before the General Assembly of the Etts. Latil shows that conditions have become acute in the agricultural machinery market, while the market for industrial vehicles seems to be saturated. The situation is critical for agricultural tractors. For each tractor manufactured in State aviation factories it is estimated that the loss is about 50,000 francs. Agricultural credits are claimed to be too rigid, and finally the lack of sales for certain agricultural products has led producers to return to horse-driven equipment. Imports of German tractors is also causing alarm.

* * *

Production of special and sheet steels fell from the 1949 quarterly average of 220,000 tons to 175,000 tons in the first quarter of 1950. Two main causes are cited: lack of capital, which means firms are living on their stocks and ordering less, and the March strikes, which particularly affected the automobile industry, main client for sheet and special steels. A slight recovery has been noted in the second quarter, but demand is still lower than it was last year. But production capacity for sheet and special steels is much greater than the demand by French constructors and tool makers, so exports will have to be developed.

* * *

The prospects for the generation of electricity for the winter are considered to be favourable; French hydro-electric reservoirs are 83·8 per cent full (95 per cent in the Massif Central), representing a power reserve of about 1150 million kWh.

* * *

A tribute was paid to Marshall Aid in the course of the inaugural ceremony of the Pebernat hydro-electric plant. The Pebernat plant, in the Ariege Valley, is supplied by a 23m head with a maximum flow of 50 cubic metres per second. Installed power, in two groups, is 11,500kVA and production reaches 50 million kWh annually. The total production of this region will reach 920 million kWh annually when other plants have been completed.

* * *

A four-year telecommunications plan has been drawn up by the Minister of Post and Telegraphs, and is being submitted for examination to the Ministry of Finance. The Minister states that the present network is quite insufficient, and it is urgent that France should improve her telecommunications system. Details of the plan have not yet been made public, but expenditure is expected to be about 25 milliard francs annually until 1955. In addition to the construction of telephone exchanges in Paris, and the installation of a number of automatic rural exchanges, "telex" lines will be installed between Paris and the South, enabling photographs of documents to be transmitted; important cable networks will also be developed, both for internal use and to facilitate communications to Italy, England and America. A special Franco-Swiss loan is planned to cover Franco-Swiss installations, and the plan also envisages improvements in telecommunications between France and Algeria.

Notes and Memoranda

Rail and Road

DEFLECTION OF THE GOLDEN GATE BRIDGE.—Four years ago instruments were installed on the Golden Gate Bridge, San Francisco, to measure the amplitude of the bridge's vibrations. According to a recent report in *Engineering News Record*, a 56 m.p.h. wind early in June caused the largest deflections yet recorded, there being a vertical movement of 42in. However, these movements were hardly noticeable to motorists because of the large span (4200ft) and the slow speed of movement; it was calculated that an additional stress of 700 lb per square inch was caused in the stiffening trusses due to the maximum deflection.

BRITISH MOTOR VEHICLE PRODUCTION.—The Society of Motor Manufacturers and Traders has announced that British motor vehicle production reached a new peak in May, when 16,250 cars and commercial vehicles left the assembly lines each week, 750 a week more than the previous top figure of March last. The number of agricultural tractors made in May reached a total of almost 10,700 units, thereby reaching and far surpassing the 10,000 level for the first time since January of last year. In addition, the month of May was a record-making one for the British motor industry's exports, nearly 37,500 cars and just over 14,000 trucks and buses having left the ports for overseas delivery—in each case about 1000 more than in any previous month. The commercial vehicle figure was almost 5500 greater than that for May of last year. May was an exceptionally good month for car exports to Canada, nearly 8800 being shipped, which was about 2500 more than the last highest figure of March. The 1600 cars sent to the U.S.A. was the largest consignment since December, 1948.

Air and Water

S.S. "COLUMBIE."—After being completely reconstructed following her war service, the S.S. "Columbie" of the French Line, will be returning to the Company's West Indies and Central American service in October.

PETROLEUM LAUNCHING LUBRICANT.—At the shipyard of Bartram and Sons, Ltd., a petroleum lubricant was used for the first time for a major launch in this country. Produced by the Anglo-American Oil Company, Ltd., it is already in use in Sweden and the United States, and the advantages claimed are that it can be recovered after the launch and used again after melting and straining, and that it does not freeze in temperatures down to 10 deg. Fah.

Miscellanea

ROOSECOTE POWER STATION DEVELOPMENT.—The British Electricity Authority has received the consent of the Minister of Fuel and Power to the development of the Roosecote power station, Barrow-in-Furness, to its full capacity. The Minister's consent was given last October for the initial installation of plant in this station; when completed it will have a total installed capacity of 120MW, made up of four turbo-alternator sets of 30MW each.

OBITUARY.—We have learned with regret of the death, on July 6th, of Mr. John B. Low, chief civil engineer in the power cable contract department of British Insulated Callender's Construction Company, Ltd. Mr. Low joined Callender's Cable and Construction Company, Ltd., in 1929, having served previously on the staff of Sir Alexander Gibb and Partners. We also record with regret the death of Mr. N. Gunn, director and secretary of Mullard Electronic Products, Ltd., which occurred suddenly on July 7th.

ELECTRIC LOCOMOTIVES FOR BRAZIL.—A recent order for ten electric locomotives for the Curitiba-Paranagua section of the Brazilian Railways has been placed with Metropolitan-Vickers Electrical Company, Ltd. On this section metre-gauge lines are being electrified on the 3000V d.c. system, and the locomotives are designed for mixed traffic service. The electric driving motors, with auxiliary electrical machines, will be made at the company's works at Attercliffe Common, Sheffield, and the control equipment at the company's Trafford Park works; the mechanical parts will be built at the Metropolitan-Vickers-Beyer, Peacock works at Stockton-on-Tees. The new locomotives are 50-ton units of the "Bo-Bo" type, equipped with four 265 h.p. axle-mounted traction motors driving through rubber-resilient gears. The one-hour-rated tractive effort is 7280kg (16,050 lb) at a speed of 40km per hour (25 m.p.h.). The control will be electro-pneumatic with series-parallel combinations and field weakening. Rheostatic braking will be provided to hold the trains on the Serra gradients, which lie a few miles inland and rise to over 3000ft in a distance of 25 miles. As high speeds up to 80km per hour (50 m.p.h.) are required, the "M-V" swing-link suspension and other special constructions have been adopted in order to ensure continuous smooth riding on the metre-gauge track.

A.B.C. COUPLER AND ENGINEERING COMPANY, LTD., AND WOTA, LTD.—A documentary film entitled "Safe and Sound" has recently been made illustrating the basic products of the companies. With a running time of twenty minutes, the film shows the various operations in producing automatic couplers, buffers and locomotive valves, for which the companies are noted. Available in 16mm and 35mm sizes, and translated into French and Spanish, the film is of particular value to those interested in railways and mines, and copies can be borrowed, without charge, upon application to Mr. E. Cook, Big Six Film Unit, 35, Endell Street, London, W.C.2.

STOVING PAINT FOR CORROSION TESTS.—A difficulty in carrying out laboratory tests on protective schemes for iron and steel has always been the absence of generally accepted standards of comparison. The British Iron and Steel Research Association's Methods of Testing (Corrosion) Sub-Committee has now partly met this difficulty by preparing a reference stoving paint, which comes within Specification CS2249. As a standard basis of comparison it is likely to be of use to all those concerned with exposure and other tests of protective schemes for iron and steel. The formulation is obtainable from the B.I.S.R.A. Corrosion Laboratory, 514, Bristol Road, Birmingham, 29. Samples of the paint are also available from the same source at a small charge.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Announcing the result of a ballot held on April 20th, the Institution of Electrical Engineers states that vacancies in the Council for 1950–51 have been filled as follows:—The President will be Sir Archibald J. Gill, B.Sc. (Eng.). The two vacancies in the office of Vice-President will be filled by Mr. H. Bishop, C.B.E., B.Sc. (Eng.), and Sir George Nelson, and the Honorary Treasurer will be Mr. H. Nimmo. Vacancies for ordinary Members of Council will be occupied by Mr. T. E. Allibone, D.Sc., Ph.D., F.R.S., Professor B. Hague, D.Sc., Ph.D., H. D. MacLaren, C.B., D.F.C., B.Sc., and C. E. Strong, O.B.E., F.A.I. (members), and R. A. Smith, M.A., Ph.D. (associate member). The Council have yet to co-opt a member to fill the casual vacancy created by the election of Sir George H. Nelson as Vice-President before the completion of his term of office as an ordinary Member of Council.

MANCHESTER FUEL EFFICIENCY EXHIBITION.—The National Smoke Abatement Society is organising a "Fuel Efficiency in Industry and Home" Exhibition, to be held at the City Hall, Manchester, from November 22nd to December 2nd next. It will be opened by the Minister of Fuel and Power. The exhibition will show plant and appliances designed to promote the better and more economical use of fuel of every kind, and it is being planned to give full prominence to both the industrial and the domestic aspects. The Society says that it will be the first comprehensive exhibition of its kind to be held since before the war, the emphasis throughout being on fuel efficiency, with smoke abatement generally implied rather than stressed. Gas, electricity and coal interests will be represented, and the scientific aspects of fuel utilisation will be shown by the Fuel Research Station. All inquiries about the exhibition should be addressed to Provincial Exhibitions, Ltd., City Hall, Manchester, 3.

PERSONNEL MANAGEMENT COURSE.—The Institute of Personnel Management is arranging a four weeks' course in personnel management, to be held at Management House, Hill Street, London, W.1, beginning on October 23rd. Membership is designed for executives with a background of industrial experience who wish to secure a knowledge of the principles and ideas which lie behind personnel management, and to see it in practice. Two lectures daily, one by a university lecturer, the other by a personnel manager, visits to factories to study specified problems, discussion in groups and conferences will provide what the Institute claims to be a high-level course in human relations. The Director of Studies will be Dr. C. H. Northcott, and the tuition fees for the course will be £40. Each member will arrange his own hotel accommodation and will meet its cost and that of meals and travel. The demand for the course is expected to be great, and early application for a place and for fuller particulars should be addressed to the Institute of Personnel Management, Management House, Hill Street, W.1.

British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

STEAM GENERATORS

638,287. February 25, 1947.—Improvements in or relating to Boilers, Danks of Netherton, Ltd., of Halesowen Road, Netherton, Dudley, Worcestershire (inventor, Norman Dalgleish).

This invention relates to shell type boilers and more particularly to a smoke tube boiler having a double or return pass. It has for its main object the increase of gas velocities by eliminating contact of the gases with the tube plate, while a further object is the provision of means to reduce the draught losses, or, in other words, to enable the boiler to be operated at higher gas speeds without a corresponding loss due to an increase in the power required for the fan drive. Referring to the drawing there is shown a "Super" economic boiler comprising a boiler shell having two furnaces, from which the furnace gases pass into the combustion chamber and thence into smoke tubes. The smoke tubes *A* are supported at the combustion chamber or rear end of the boiler shell in a tube plate *B* and similarly at their front ends in a second tube plate *C*. In order to eliminate direct contact between the combustion gases from the furnaces and the tube plate *B*, the smoke tubes constituting the first or upper pass of gases are extended beyond the tube plate and are connected to the interior of the combustion chamber through a secondary plate or partition indicated generally at *D*, which forms part of the front wall of the combustion chamber. In the construction shown, each smoke tube at its inlet end connecting with the combustion chamber is fitted with a short tubular venturi-throated extension piece *E* formed preferably of a heat-resistant alloy, the entry ends of which are secured to the secondary plate *D* of the combustion chamber. The extension tubes are conveniently provided with hexagonal flanges so as to form a compact nest with the flanges in edge-to-edge contact, thereby presenting a closed wall to the gases. It will be observed that the combustion chamber is constructed as a separate unit and is independent of the boiler shell. It consists of a box-like structure having an outer casing with a brickwork lining, into which the combustion gases pass from the furnaces through a similarly lined passage. The chamber is carried on a base structure. As indicated by the arrows the combustion gases from the interior of the combustion chamber pass directly into the upper pass *F* of smoke tubes through the extension tubes without

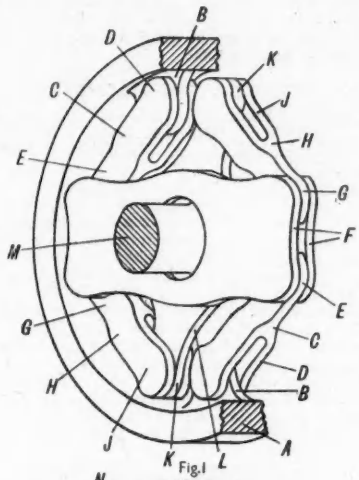


Fig. 1

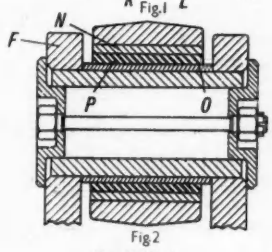


Fig 2

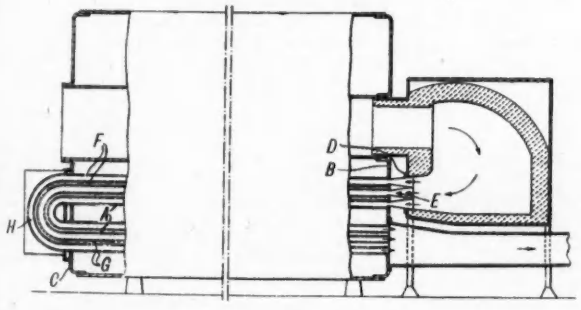
No. 638,240

physical contact with the end plate, as the result of which the temperature of the plate *B* will not exceed substantially boiler water temperatures. It will be observed that the interior space between the plate and the front wall of the combustion chamber is open to atmosphere through a passageway. At their discharge ends individual tubes in the upper pass *F* of smoke tubes may be coupled directly to tubes in the return pass *G* by means of suitable coupling tubes *H* formed of mild steel or heat-resistant alloy so that the gases pass straight from one smoke tube to another without undergoing expansion and contraction.—*June* 7, 1950.

RAILWAY ENGINEERING

638,240. January 9, 1948.—Improvements in and Relating to Parallelogram Link Drives for Locomotives, The English Electric Company, Ltd., of Queens House, 28, Kingsway, London, W.C.2, and John Oliver Philip Hughes, of Willans Works, Rugby, Warwickshire.

The invention relates to parallelogram link drives for locomotives arranged between a gearbox or the prime mover in a locomotive frame, and the driven locomotive axle, so as to allow the bouncing of the axle with respect to the frame while the axle is in torque connection with the gearbox or prime mover. It is an object of the present invention to provide a parallelogram link drive for locomotives which, in addition, permits a tilt of the driven axle with respect to the axis of the gearbox or driving component and which dampens any shocks arising from too violent upward or downwards movements of the driven axle. This is achieved by using pre-loaded rubber bushes for the connection of the links both with the driving component and with the driven axle. Fig. 1 is a perspective diagrammatic view of an embodiment of the parallelogram drive according to the invention with parts broken away for clarity and Fig. 2 is an axial section through a link joint on a larger scale. The driving component *A* has the shape of a ring which is connected or integral with the large toothed gear wheel of the gearbox (not shown) that receives its drive from the prime mover such as a steam or gas turbine. This ring has two internal lugs *B* arranged diametrically opposite one another to which two links *C* are articulated with their forked ends *D*, the tail ends *E* of which are linked with two floating levers *F* symmetrically arranged on both sides of the links. These floating plates *F* are in turn linked to the tail ends *G* of links *H*, the forked ends *J* of which are articulated to the ends *K* of a two-armed lever *L* which is integral with the driven axle *M* of the locomotive. The floating levers *F* have central circular recesses allowing a wide clearance to the axle passing through them on either side. A feature of the invention is that the two-armed lever *L* is straight and flat in the centre plane of the parallelogram drive and that the links *C* and *H* are identical with one another, only reversed in position, which in conjunction with the duplication of the floating lever *F* allows completely symmetrical design of the drive, with a minimum of different components. In Fig. 2 the articulation between the tail end and the two symmetrically arranged floating levers *F* as shown is effected by means of a ready made assembly of two concentric bushes *N* and *O* with a pre-stressed rubber sleeve *P* arranged between and bonded to them.—*June* 7, 1950.



No. 638,287

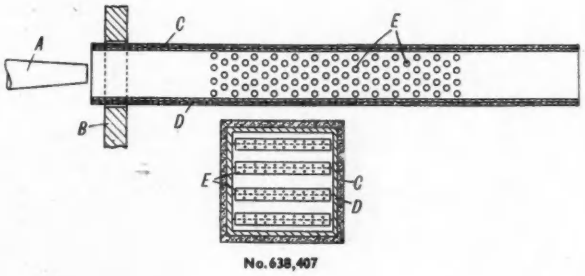
MISCELLANEOUS

638,389. November 8, 1947.—Improved Method of Bending Metal Tubing, W. G. Jenkinson, Ltd., of 156, Arundel Street, Sheffield, 1, and Horace Arnold Jenkinson, of the company's address.

According to this invention a method of bending tubes is provided, comprising the steps of filling the tube, or the part to be bent, with water and freezing it, with or without the addition to the water before freezing of a substance or substances, such as ammonium chloride, sawdust, asbestos and cotton wool for modifying the crystalline structure of the ice and/or means, such as a piece of rope, for reinforcing the ice mass, bending the tube in the normal way, allowing the ice to melt, and draining and drying the tube. In carrying out the invention the tube to be bent is temporarily closed at one end, or adjacent the part to be bent, and filled with water, which is then frozen by any convenient form of refrigerating means, the natural expansion in forming the ice ensuring as perfect a filling as possible so that risk of buckling, flattening or rupture is reduced to a minimum. During the bending process, which is performed in the normal manner, the core of ice fractures with probably a slight melting at the points of fracture so that the ice crystals move freely relatively to one another to conform with the continually changing shape of the tube as it is being bent. The core can remain frozen long enough to return the tube for bending, while, in addition, it can readily be removed after bending by simply warming and pouring the liquid off, there being no danger of any of the core remaining in the tube. There is no necessity for any subsequent cleaning operation.—*June* 7, 1950.

638,407. May 27, 1948.—Noise-Suppressing Apparatus for Use in Conjunction with Stationary Jet Propulsion Engines, Douglas Jack Wayth Cullum, of 8–9, Flower's Mews, Archway Road, London, N.19.

In the construction and testing of jet propulsion engines, such as in research and test workshops, the engines are suitably supported on their benches or equivalent with their jet nozzles directed towards an aperture or respective apertures in the wall of the workshop in order that the flames and products of combustion of the jets shall be discharged into the outside atmosphere. A great noise is caused by the jets during test. The object of the invention is to overcome this noise and to provide an efficient detuner, economical to produce and maintain, comparatively simple to install and generally of a robust character with economy, in weight and structural materials involved. As shown in the drawings, the gas stream from the exhaust *A* of the jet engine is projected through an aperture in the wall *B* of the engine enclosure into a detuner duct or tunnel. The detuner tunnel may be a concrete or brick duct *C* (of suitable length, say, 60ft and about 12ft in width and height), lined with thermal insulation *D* and having throughout its length, or for only a part thereof, a dispersion of protected sound-absorbing or baffle units *E*, which are arranged in vertical rows alternately staggered to give the necessary break-up of the sound which is concomitant with the passage of the gas stream. These units, as shown, consist of perforated metal tubes (conveniently of circular cross section), within which sound-absorbing material (such as rock wool) is housed. End plates or covers are provided for the protective tubes by which plates the tubes are mounted on the sides of the tunnel. The cross sections of these noise baffle units are arranged to suit requirements; thus, for example, they may be of circular, elliptical or aerofoil shaped section. A perforated metal lining may be included in the tunnel with fireproof and/or sound-absorbing material lying between the lining and the walls of the



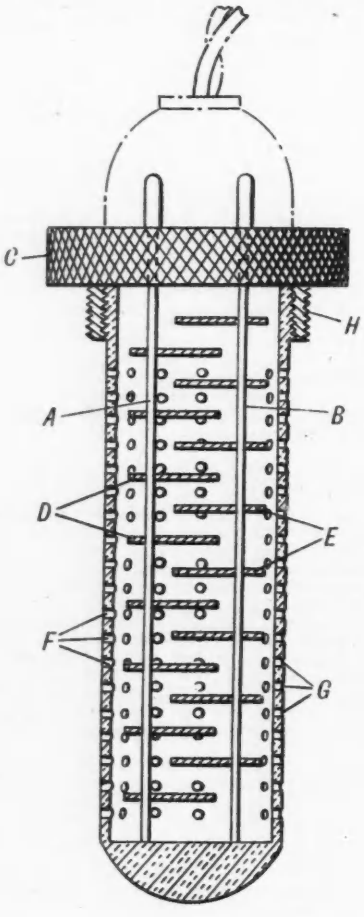
No. 638,407

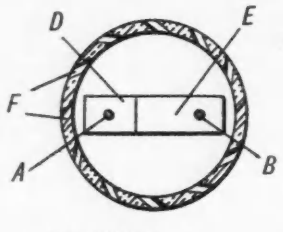
tunnel, which, however, may otherwise be suitably lagged to absorb sound and resist heat.—*June 7, 1950.*

INTERNAL COMBUSTION ENGINES

638,639. July 8, 1947.—IMPROVEMENTS IN IMMERSION ELECTRICAL HEATERS FOR PRE-HEATING INTERNAL COMBUSTION ENGINES OR OTHER PURPOSES, Charles Fletcher Lumb, of Ballard Coombe, Coombe Warren, Kingston Hill, Surrey.

This invention relates to immersion electrical heating devices for heating liquids, and has particular but not exclusive application to pre-heating the cooling water in the water cooling system of an





No. 638,639

internal combustion engine of a car while the latter is idle, particularly in cold weather in order to maintain the engine in a warmer condition for easy starting. The accompanying drawing shows an immersion heater comprising a pair of electrodes *A* and *B*, each of which is of metal, preferably copper and in the form of a rod, the rods being arranged parallel to each other and having one pair of adjacent end portions sealed in a disc-like body *C* of insulating material. The ends of the electrodes project into the body of insulating material and are respectively connected to pins whereby a two-pole socket can be employed for connecting the rods to electrical supply and return leads. Each rod has secured to it by brazing, a plurality of thin fins or plates *D* and *E*, preferably of copper, which extend transversely to the rod to which they are secured. The plates may be uniformly spaced at intervals on the rods. The plates on one rod project into the spaces between the plates on the other rod. The rods are surrounded by a porcelain, glass, or thermosetting plastic bulb of cylindrical form, and hemispherical at one end. The bulb is secured, by its open end, to the inner end of the disc *C* and it has two oppositely arranged series of openings *F* and *G* extending through the cylindrical wall. The disc *C* also has an exteriorly screw-threaded sleeve *H* of metal whereby the heater can be inserted through, and fitted into, a screw-threaded opening in the water jacket of the engine. In freezing weather a thermostat is set, so that the water in the system is maintained at a temperature just above freezing point, the water circulating on the thermosiphon principle, so that all parts of water in the system will be warmed.—*June 14, 1950.*

REFRIGERATING MACHINERY

638,413. September 27, 1946.—EVAPORATOR FOR ABSORPTION REFRIGERATING MACHINES, Giovanni Bianchi, of Via Solari 12, Milan, Italy.

It is well known that in continuous-cycle absorption refrigerating machines the evaporator is generally either of bulbous form and completely or substantially completely surrounded by a diffuser casing, generally made of light alloy, or is in the form of an evaporating coil of appropriate shape, which may partially be provided with ribs. Both the aforesaid arrangements, however, are not altogether free from inconvenience. According to this invention, evaporation is carried out in three stages by means of upper and lower bodies with a series of interconnecting conduits. The accompanying drawing Fig. 1 shows a longitudinal sectional view, with parts in elevation, of an evaporator constructed according to the invention, while Fig. 2

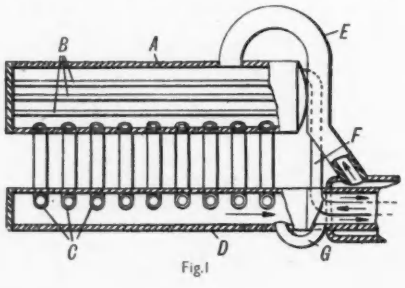


Fig.1

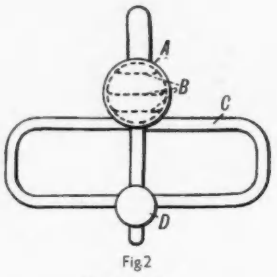


Fig.2

No. 638,413

is an end elevation of Fig. 1. The evaporator consists of an upper tubular body *A*, within which are provided a number of horizontal partitions or diaphragms *B*, which divide it into superimposed compartments, the partitions being apertured or being dimensioned so as to provide marginal passages by which adjacent compartments are in communication with one another. The body *A* is connected, by means of a series of U-shaped conduits *C* opening into the lowermost compartment of the upper body *A* at opposite sides thereof, with a lower tubular body *D*, the conduits opening into the lower body also at the opposite sides thereof. *E* is the intake pipe for the pressure compensating gas, *F* the inlet for the liquid ammonia, and *G* a discharge trap. The first stage of the ammonia evaporation, in contact with the pressure compensating gas, takes place within the body *A* at the lowest temperature. The gaseous mixture thus formed, with the remaining liquid ammonia, then flows through the conduits *C*, where further partial vaporisation of the liquid ammonia takes place, while the gaseous mixture commences to give up cold to the surrounding air, which in this manner becomes cooler. Finally, in the body *D* the heating of the gaseous mixture is intensified, at the cost of heat from the surrounding air, which produces evaporation of the last remaining liquid ammonia. The ice production pans can be disposed suitably in the apparatus adjacent to the evaporating conduits *C*, thus ensuring, due to the presence of cold air current which is flowing outside the evaporator, a good production of ice. Both the upper and lower bodies, together with the intercommunicating conduits, may, if desired, be provided with ribs.—*June 7, 1950.*

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of British Chemical Manufacturers

Fri., Sept. 29th, to Sun., Oct. 1st.—Chemical Works Safety Conference at Scarborough.

British Association

Wed., Aug. 30th, to Wed., Sept. 6th.—Annual meeting in Birmingham.

Institution of Metallurgists

To-day to Sat., Sept. 30th.—Science Museum, South Kensington, London, S.W.7, Exhibition, "Metals in the Service of Mankind," weekdays, 9.30 a.m. to 6.30 p.m.; Sundays, 2.30 p.m. to 6.30 p.m.

Institution of Mining and Metallurgy

Tues., Sept. 19th, to Sat., Sept. 23rd.—Conference on Wire Ropes in Mines, at Ashorne Hill, Leamington Spa, Warwickshire.

Scientific Instrument Manufacturers' Association

Tues., Sept. 5th, to Fri., Sept. 8th.—Exhibition and Symposium at the Examination Hall, Queen Square, London, W.C.1.

Stephenson Locomotive Society

Sat. and Sun., July 22nd and 23rd.—Tour of Running Sheds, Bristol, Newport and S. Wales Area. Scottish members visit Carstairs Depot.

Personal and Business

MR. E. CARNEGIE has retired from the board of the British Oxygen Company, Ltd.

MR. P. L. JONES has been appointed a director of Swan, Hunter and Wigham Richardson, Ltd.

THE MINISTER OF TRANSPORT has appointed Lieut.-Colonel Steven J. L. Hardie and reappointed Captain Sir Ian Bolton to be part-time members of the British Transport Commission.

THE SKEFKO BALL BEARING COMPANY, Ltd., states that the address of its Leicester branch office has been changed from Hannam Court Buildings, Charles Street, to 167, Belgrave Gate, Leicester. The telephone number is Leicester 58722.

THE GENERAL ELECTRIC COMPANY, Ltd., announces the retirement of Mr. W. M. Cranston, manager of the fan and fractional horsepower motor department of the Witton works. Mr. Cranston entered the service of the company in 1910.

DUNLOP RUBBER COMPANY, Ltd., states that Mr. B. J. Haill has been appointed works manager of the new factory on the Hirwaun Trading Estate, South Wales. Mr. A. Taylor has succeeded him as production superintendent of the Dunlopillo division of the Walton factory.

RICHARD THOMAS AND BALDWINS, Ltd., and the Steel Company of Wales, Ltd., announce the formation of a company, entitled R.T.S.C. Exports, Ltd., which will act as the organisation for the effecting and carrying through of the export sales of mild steel flat rolled products manufactured by them and their respective subsidiaries. The directors of the new company are Mr. H. F. Spencer (chairman), joint assistant managing director of Richard Thomas and Baldwins, Ltd., and Mr. E. Julian Pode, managing director of the Steel Company of Wales, Ltd. The secretary of the company is Mr. J. Idris Roberts, the registered office being at 47, Park Street, London, W.1.

Contracts

BRITISH THOMSON-HOUSTON COMPANY, Ltd., has received an order for two electromagnetic couplings and a twin-pin, single-reduction gearbox for the geared diesel drive of an 8400-ton cargo vessel propelled by two 4500 h.p. Sulzer engines. They will be the largest electromagnetic couplings to be built in this country.

WEIR WOOD IMPOUNDING RESERVOIR.—The Weir Wood Water Board has accepted the tender of Richard Costain, Ltd., Dolphin Square, London, S.W.1, for the construction of the Weir Wood impounding reservoir. The work involved consists of an embankment, 560 yards long and 41ft high, with river diversion and ancillary works, the total sum involved being about £415,000.

DISTINGTON ENGINEERING COMPANY, Ltd., Workington, Cumberland, has received an order for thirty type "G-20" shaker conveyors and type "F3" duckbill loaders for delivery to Poland. Fifteen similar machines were delivered to Poland by the company only eight months ago. The value of these two orders, including standard accessories, has been estimated to be in the region of £125,000.